

CHEMICAL & METALLURGICAL ENGINEERING

New York, Aug. 1, 1918

McGraw-Hill Company, Inc.

Vol. XIX, No. 3 25c a copy



Prevents Glass Breakage

Deflection of the supporting bar is the chief cause of glass breakage in skylights.

Aspromet Glazing² Construction

(Formerly Waugh Glazing)

carries practical assurance against glass breakage because the Aspromet Bar *cannot deflect*. Its rolled steel beam is designed to safely carry the total live and dead loads.

To make Aspromet Glazing *permanent* and *eliminate upkeep cost*, APM rust-proof protection is applied to this supporting bar as well as all other

metal parts. They *do not even require painting*, for APM protects them completely from the weather, corrosive vapors and chemical fumes that would quickly destroy unprotected steel.

Bulletin 5815 describes Aspromet Glazing and its application to chemical and other plants. Write for a copy.

Aspromet  **Company**
Pittsburgh
(FIRST NATIONAL)
(BANK BUILDING) U.S.A.
Formerly Asbestos Protected Metal Co.

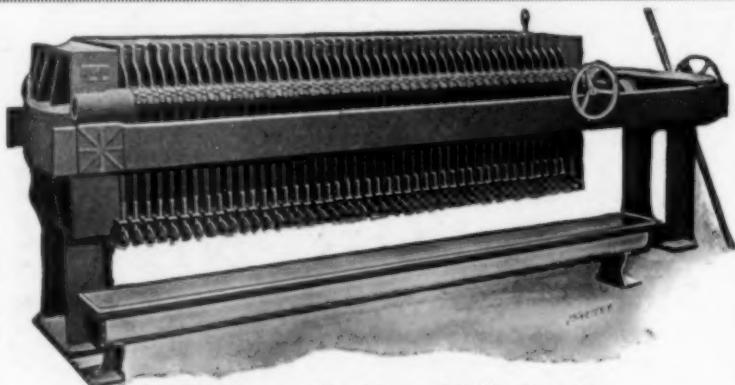
**For Big Production and Low
Operating Cost**

SHRIVER FILTER PRESSES

They increase output and effect marked savings in filter cloth replacements and the recovery of values. Little attendance and less wash water adds to their economy.

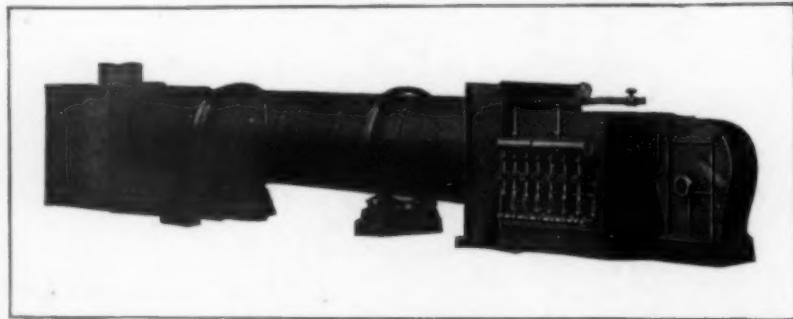
Have wide joint surfaces. Accurate finishing of plates and frames, coupled with an efficient tightening device, prevents leakage.

Presses for all industrial filtration. Small presses for laboratory work.



T. Shriver & Co., 808 Hamilton St.
Harrison, N. J.

STEAM HEATED AIR DRYERS



for drying Borax, Nitrate of Ammonia, Baking Powder, etc.

Have equipped largest chemical plants in the world.

Also Direct Heat Dryers for By-Products.

Material carried in stock for standard sizes.

American Process Co.
68 William St., New York

WHEN IN THE MARKET

**Don't Forget that We Supply
the Following Metals and Alloys**

Ferro-Titanium, 25% Ti
Chromium, 98.99% C.
Ferro-Chromium, 60% C.
Ferro-Vanadium, 40% Va
Ferro-Molybdenum, 80% Mo
Cobalt, 97%
Tungsten, 95%
Ferro-Tungsten, 70%

Manganese, Pure
Manganese-Copper, 30/70%
Manganese-Titanium, 30% Ti
Manganese-Aluminum, 25% Mn
Phosphor-Copper, 1% Phos
Silicon-Copper, 10% Si
Phosphor-Tin, 5% Phos
Nickel-Copper, 50-50%

We are also in a position to quote on 50% Electro Furnace Ferro-Silicon manufactured by the Keokuk Electro Metals Company, of Keokuk, Iowa. This plant is now turning out a very high grade alloy, and, being centrally located, offers superior shipping facilities and freight rates. We represent this Company as exclusive selling agents.

Foundries making Brass, Bronze, German Silver, Nickel, Aluminum or composition castings should be sure to investigate our Pure Manganese and Manganese Alloys.

Ask for our pamphlet No. 2041.

METAL & THERMIT CORPORATION

(Successors to Goldschmidt Detinning and Goldschmidt Thermit Co.)

THE EQUITABLE BUILDING, 120 BROADWAY, NEW YORK

Chicago—7300 So. Chicago Ave.
San Francisco—329-333 Folsom St.

Pittsburgh—1427-1429 Western Ave.
Toronto, Ont.—103 Richmond St., W.

Published SEMI-MONTHLY on the FIRST and FIFTEENTH of each month

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

McGRAW-HILL COMPANY, INC.

Tenth Avenue at 36th Street
NEW YORK

JAMES H. McGRAW, President

ARTHUR J. BALDWIN, Vice President E. J. MEHREN, Vice President
EDWARD CALDWELL, Treasurer JAMES H. McGRAW, JR., Secretary

TELEPHONE, 2840 Greeley.

CABLE ADDRESS, Machinist, New York

WASHINGTON, 1410 H. St., N.W. SALT LAKE CITY, Newhouse Bldg.
CHICAGO, Old Colony Bldg. PHILADELPHIA, Real Estate Trust Bldg.
SAN FRANCISCO, Rialto Bldg. CLEVELAND, Leader-News Bldg.
LONDON, Hastings House, Norfolk St., Strand.

H. C. PARMELEE, Managing Editor
ELLWOOD HENDRICK, Consulting Editor
ERNEST E. THUM, Western Editor
WALLACE SAVAGE, Assistant Editor

J. MALCOLM MUIR, Manager

Yearly Subscription price for United States, Mexico and United States dependencies, \$3; all other countries, \$4. Single Copy, 25c. When change of address is ordered, the new and the old addresses must be given. Notice must be received at least 10 days before change takes place. No back copies for more than three months.

Copyright, McGraw-Hill Co., Inc., 1918. Entered as Second-Class Matter at the Post Office at New York, N. Y., under the Act of Congress, July 1, 1918.

Circulation of this issue 11,000 copies

CONTENTS for August 1, 1918

Volume 19, Number 3

EDITORIAL

September's Conventions	109
Platinum, Rice and War Weddings	109
Test Iron Ores and Fluxes for Potash	110
Science and the German Language	110
Flexibility of the Steel Industry	111

READERS' VIEWS AND COMMENTS

Oil Shales, Albertite and Paper Shales. By Louis Simpson	112
The Economic Position of Oil Shales. By Jac. C. Morrell and Gustav Egloff	112
Organic Reagents for Research Purposes. By C. E. K. Mees	113
Conforming to the Prior Art in Flotation. By R. C. Canby	113
Metallurgy of Zinc. By J. H. Hastings	114
Sugar Consumed by the Allies	114
Western Chemical and Metallurgical Field	115
Graphite Crucibles Placed on List of Restricted Imports	116
Alien Property Custodian Seizes Metal Concerns	117
Government Controls Chlorine Production and Distribution	117
Platinum as Seen by the Jeweler and the Chemist	118
New Government Agency Taking Census of Industries	119
Corporation Organized to Sell Enemy-Owned Property	119
Distribution of Niagara Power	120
The Metallography and Heat Treatment of Metals Used in Aeroplane Construction. By F. Grotte	121
Ownership of Chemical Concerns Probed by Alien Property Custodian	123
Flotation Apparatus, Their Design and Operation. By A. W. Fahrenwald	129
Skilled Enlisted Men to be Returned to Industries by War Department	134
Aluminum and Its Light Alloys. By Paul D. Merica	135
Asphalt and Petroleum Residues in 1917	140
The Derestation of Rubber. By Andrew H. King	141
Chemists to Discuss War Necessities	145
The Human Element in the Mill	146
Gases Used in Warfare	150
Rulings on Importation of Magnesite and Manganese	150
Synopsis of Recent Chemical and Metallurgical Literature	151
Recent Chemical and Metallurgical Patents	152
The Northrup-Ajax Induction Furnace	155
Hydraulic Operation of Furnace Doors	156
Development in Grading Solids	157
Licensing of Engineers	157
Book Reviews	158
Personals	158
Obituary	159
Market Reports, Non-Ferrous, Iron and Steel, Chemical Market and Price List	159
Industrial News—Plant Construction, Catalogs and New Publications	163

September's Conventions

THE month of September promises to be a busy one for those who have occasion to attend professional gatherings. The American Institute of Mining Engineers holds its one hundred and seventeenth meeting in Colorado through the first week of the month, visiting Denver, Colorado Springs, Cripple Creek and Pueblo. The American Chemical Society will convene in Cleveland, Ohio, the following week, holding meetings on the tenth to the thirteenth inclusive. Apparently no meetings have been scheduled for the third week in the month but in the following week the Fourth National Exposition of Chemical Industries will be held at Grand Central Palace, New York. The American Electrochemical Society closes the fall schedule with meetings at Princeton, N. J., from Sept. 30 to Oct. 2.

This is a rather rapid-fire program for those whose interests in chemistry and metallurgy make attendance on the conventions of these societies desirable if not essential. In spite of the earlier agitation against wartime conventions there seems to be no abatement of interest, which may be attributed to the fact that not only are the conventions profitable in themselves, but they afford a very desirable form of relief from the strenuous personal schedules which most technical men are obliged to lay out for themselves.

It has been our own observation that very definite and tangible results of benefit to the war program of the country come from these professional gatherings. There is much information of a technical nature which can not be offered for publication, but which men will communicate to each other freely if the opportunity of a personal meeting is afforded. The convention supplies the common meeting ground with the right atmosphere for professional intercourse. It will be our pleasant duty to report all these gatherings fully for the benefit of those who cannot attend.

Platinum, Rice and War Weddings

WE NEED an enlightened public conscience on the subject of platinum. We have one on the subject of food and it worked wonders in enabling us to conserve our supplies, feed ourselves and our Allies, and in general get the matter so well in hand that the Food Administrator could announce recently that there is no danger of a crisis. If the general public had as keen a sense of patriotism regarding platinum as it has on the subject of food, we would hear less of a platinum shortage and our supply of the metal would be plainly useful instead of doubtfully ornamental.

What the lack of appreciation of the platinum situation means among good citizens of a high degree of

intelligence is well illustrated by a recent war wedding to which we were a witness. The groom was an army officer, shortly to sail overseas in the performance of his patriotic duty, there to make the supreme sacrifice if necessary, and placing reliance for his safety and support on the steady production of munitions at home. The bride was a fair daughter of a family of the better class, but more familiar with platinum as an ornament than a catalyst. Because platinum has been in vogue for wedding and engagement rings, and wishing to present his bride with the best the market afforded, the groom had selected jewelry of the white metal, wholly unmindful of the anomaly of a soldier sacrificing in ornamentation that which is an essential to the production of the munitions on which he must rely for his personal safety. And after the ceremony was over and the couple left the scene, the assembled company patriotically refrained from spoiling fifteen cents worth of rice wherewith to perpetuate an age-old tradition on such occasions. All of which suggests the need of a conscience on platinum as first mentioned. Is it not time that chemists and metallurgists spread the gospel of platinum for munitions and publicly frown upon slacker uses of platinum? The people are intelligent and patriotic at heart, but uninformed and therefore careless in their actions. It is wholly a question of education, for which technologists are to be held responsible.

Test Iron Ores and Fluxes for Potash

DOMESTIC production of potash in 1917, according to the U. S. Geological Survey, amounted to 32,366 tons of available K₂O. Natural brines yielded 20,652 tons and easily proved to be the premier source. Kelp was second with 3572 tons; and molasses, alunite and cement-kiln dust followed with 2846, 2402 and 1621 tons respectively. Thereafter no item in the list attains the dignity of a production requiring more than three figures, and blast-furnace dust ends the list with a production of but 185 tons K₂O, being appreciably less important than wood ashes, the residue from evaporation of Steffens water from sugar refineries or similar residues from wool washing and other industrial wastes.

Judged from these figures alone, blast-furnace dust would not appear to be much of a factor in the prospective production of potash in this country. And yet there are certain technical and economic features about the recovery of potash from this source that lead us to urge chemists and metallurgists everywhere to be diligent in analyzing all iron ores and fluxes for this important mineral.

Our future independence in potash supply is likely to rest largely in that item of our production which is most nearly a cheap by-product. Careful and continued geological exploration for several years has afforded no hope of discovering deposits comparable to those of Europe, or indeed any that seem important. By-products, therefore, assume added value and it behooves us to take careful stock of this asset. The by-product which will be most valuable will be one that accompanies a material for which there is an unlimited demand, so that no glut of the principal market can reduce the output of the minor product.

Iron ores and fluxes fulfill in a peculiar degree all the

conditions for an almost ideal source of potash as a by-product, and make a careful survey desirable if not imperative. These materials are used in large quantities, so that if they contain what would otherwise be a negligible percentage of potash they will nevertheless yield an appreciable total in the aggregate. The potash content can be recovered in the process of cleaning the furnace gases, which is in itself a desirable operation even if no valuable by-product were sought. It is quite evident, then, that if our large iron deposits should be found to be potash-bearing, we have a source of potash that is practically without expense. Transportation and treatment charges would be absorbed by the principal product, and the by-product would be clean profit. On such a basis it would not be difficult to compete with German potash at any price. We deem the subject worthy of the most careful investigation and shall be glad to open our columns to those who may undertake researches in this line or who may have knowledge of the extent to which potash exists in our iron ores, dolomite limestones and coke.

Science and the German Language

THREE is a great deal of hysteria in the daily press about dropping the study of the German language from schools and even colleges. We see no good in the plan. It reminds us of the man who bit off his nose to spite his face. Why interject non-essentials at a time like this? Of course we do not favor schools conducted in the German language, and we believe in making short shrift of German propaganda either now or at any other time—until the German people get over their present delirium and know enough to be ashamed of themselves.

Let us try to get a broad view of the situation. The Germans followed Kant in the belief that there is no relation between science and ethics. The Prussian drill in obedience to authority had its effects here as well as elsewhere and Kant, being a philosophical authority, became the final and binding word upon the German conscience. For generations the German people have been almost feeble-minded in their inhibitions against the voice of authority. "There can be no revolution in Germany," said Heine, "because revolution is *verboten*." But now the Germans have very effectively done as they were told; they have divorced science from ethics and—we see the results.

In times past, however, they had their periods of enlightenment, and in elucidation of this we shall repeat an example that we have mentioned before. It was sometime in the seventies that Professor Josiah Willard Gibbs of Yale University read a paper on the phase rule, before the Connecticut Academy of Sciences at New Haven. It is not of record that anybody understood what he was talking about. Then many years later, sometime in the nineties as we recall it, the elder Ostwald, being still in his right mind, set out to find all that he could about Willard Gibbs, whose infrequent contributions had aroused his lively interest. Looking over the published transactions of the Connecticut Academy, he discovered to his unutterable delight the very thing he had long been wishing for: the phase rule stated and worked out. He immediately trans-

lated it into German, giving full credit to the author and his source of information, and published it to the great illumination of the scientific world. It is fair to say that we Americans got the phase rule from the German, although it appeared originally within less than 100 miles from New York, and it was written and delivered in English.

If we didn't know enough then to see a good thing when it was put before us, it stands to reason that we are capable of letting other good things slip by unobserved, even in this day of blind rage. And it is a bad thing for science in America or anywhere else to let additions to enlightenment pass by, whether they come from Germany or Zambesi or Timbuktu. Facts are facts and information is information. We must not misuse them, neither must we close our eyes to them. The German language is to-day the richest in chemical literature as it is also in certain other branches of science, and to prevent the study of it would be nothing more than giving way to hysterics. It would often involve waiting a year for partial and inadequate translations. The war is not won yet; everyone of us has a man's job ahead of him, and there is neither profit nor wisdom in browsing about in the silly-ass pasture.

Flexibility of the Steel Industry

THE combination in the steel industry of all steel-making departments being operated as fully as possible with many finishing departments operating at only about 60 per cent of their capacity is one that would not have been believed possible a few years ago. Normally the sum total of the finishing capacity exceeds but slightly the total ingot-making capacity, and when there is full production of ingots there must necessarily be nearly full employment of finishing departments. For a time after the European war started, moreover, there was erection of open-hearth furnaces without attendant increases in finishing capacity, thus making the alignment between steel-making and steel-finishing capacity closer than ever.

Yet the condition to-day is that every works is striving to turn out a maximum tonnage of ingots while the rod, merchant and sheet mills are operating at only about 60 per cent of capacity, the production of steel pipe is light and the production of rails far below capacity. Ingots, blooms and billets are extremely scarce. The finished products that are most needed for war purposes are being produced in great volume while the products less needed for war purposes are being produced in small volume.

The steel industry is showing a flexibility that would not have been expected. Indeed, there were many predictions a year and more ago that our entrance into the war could not make steel of all descriptions scarce, for the war would require large tonnages of some finished forms and little tonnage of others, which perforce would be plentiful. Thus the steel industry has adapted itself in remarkable manner to the peculiar demands made upon it.

Several causes have contributed to make this alignment possible. The two chief factors are the heavy production of shell steel and the large increase in plate-

rolling capacity. Precise figures are not available, but a fair estimate is that half a million net tons of shell steel a month is being made. The records at Washington are made up in net tons, so that unit may as well be used. This shell steel involves the use of scarcely any finishing capacity. Next, there is an output of plates probably materially in excess of half a million tons a month, an increase of considerably more than 50 per cent over the output in 1916, when every effort was being made to swell the production of plates, which were easily the rarest commodity in the steel market. The major portion of the new plate mill construction has been without increase of capacity of the attendant steel works and indeed some plate mills have been built without slabbing mill capacity, requiring slab ingots or blooming mill slabs.

A relatively minor factor from a tonnage standpoint, and yet an important one, is the heavy operation of the tin-plate mills. They have lately been producing at the rate of 160,000 net tons a month, against an output of 115,000 tons a month in 1916. This heavy operation tends to make crude steel scarce in general, and in particular it makes such a drain upon the sheet-bar supply that the sheet mills are but poorly provided. The proportion of the total steel supply passing into sheet bars is not much under normal, but the division of the sheet-bar supply is quite abnormal.

The structural mills are not operating at an abnormally heavy rate but are probably consuming their usual proportion of the total steel supply, and this leaves it that the operations of rod bar, rail, sheet, merchant and skelp mills are very far below capacity, probably averaging in the neighborhood of 60 per cent. It is understood that the rod mills are definitely limited to a 60 per cent operation.

The production of ingots in June was at the rate of about 43,500,000 gross tons a year, there having been an increase in the rate each month since the very low rate of last January. For a period of years before the war the output of finished rolled steel was almost precisely, year by year, 76 per cent of the weight of ingots reported. On account of the discard involved in shell steel production the percentage of rolled steel may have declined a trifle, but 75 per cent is a safe factor to use, and this would mean 3,000,000 net tons of finished rolled steel a month when ingots are being produced at 43,500,000 tons a year. With at least 1,160,000 tons involved in shell steel, plates and tin plates the operations of other finishing departments must be light.

There is a very interesting coincidence, that plates, structural shapes and tin plates are not carried in stock by mills, wholesalers or retailers to any extent. Merchant bars, pipe, wire products and sheets are normally carried in stock. At any one time there is a very considerable stock in the country. There is no scarcity of these materials from the standpoint of carrying on the war, but there is a possibility, with the continued restriction in output, that eventually a serious shortage will come to light. The steel industry has responded quickly and fully to the peculiar demands of war. The probabilities are that these demands will continue and may even increase, but should they slacken there is a reserve of demand for steel in replenishing the stocks throughout the country, now being depleted.

Readers' Views and Comments

Oil Shales, Albertite and Paper Shales

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the interesting article published in your June 1 issue on "The Economic Position of Oil Shales" by Jac. C. Morrell and Gustav Egloff certain errors occur.

On page 603 appears a reference to "albertite, an oil shale from New Brunswick, Canada, known as paper shale." I desire to point out that albertite is not an oil shale nor has it ever before been so called or known as "paper shale." Albertite is solidified oil, found in a vertical vein that cuts through the many beds of shale found in the valley of the Frederick Brook and known as the Albert Mines.

Many years ago the albertite in the vein was mined. The mineral was said to have an analysis as follows: Volatile matter 54 per cent fixed carbon over 45 per cent, and ash only 0.17 per cent. On retorting it is claimed that the albertite yielded crude oil of from 100 Imp. gallons to 130 Imp. gallons per ton. The paper shales of which there are large masses exposed in the banks of the Frederick Brook yielded the following:

- A. 32 Imperial gallons oil and 38 lb. sulphate of ammonia.
- B. 34 Imperial gallons oil and 38 lb. sulphate of ammonia.
- C. 42 Imperial gallons oil and 38 lb. sulphate of ammonia.

Besides the large masses of paper shales, there are also exposed distinct beds of black and curly shale, which yield as follows:

1. 41 Imperial gallons oil and 89 lb. sulphate of ammonia.
2. 63 Imperial gallons oil and 92 lb. sulphate of ammonia.
3. 52 Imperial gallons oil and 73 lb. sulphate of ammonia.
4. 42 Imperial gallons oil and 52 lb. sulphate of ammonia.

All these analyses were made in the laboratory of the Department of Mines, Ottawa, and are more correct than those given in Table VI, where the results of samples from Albert Mines and from the Frederick Brook are given separately (in some cases probably duplication has occurred) whereas all belong to the same property, viz., Albert Mines. It will be noted that these results are markedly different from the results obtained from shales in Scotland, where the paper shales are not considered to be of economic importance, and where the shales that are low in oil content are usually high in the yield of sulphate of ammonia.

Nor is it correct to claim that the paper shale contains considerable quantities of fish remains; nor can the presence of the fish remains, as present in the Albert Mines shales, prove the origin of the hydrocarbons. It is true that in one exposure of one of the beds of the paper shales, which at this point are so badly crumpled that at first it would appear as if the whole formation has been tilted on end, there are

considerable of such remains. Their presence is, of course, interesting, but as "one swallow does not make a summer" so the presence of fish remains in the outcroppings of one bed of shale, of small thickness, would in my opinion if anything, tend to prove that the hydrocarbon contents of other beds of shale did not owe their origin to the remains of fish. Why should the remains be plentiful in this one thin bed and yet be entirely or almost entirely absent in the many other beds, all of which yield oil in considerable quantities.

So far as I am aware the shale from the bed that contains these remains has never been analyzed. Some day, as a matter of scientific interest, I hope that the shale of this bed will be analyzed and also of the beds above and below, in which no remains are found.

In the second article by the same authors in your issue for July 15 I call your attention to the comparative statement given on page 95, clause 6, of the general summary on the same page, and clause 12, page 96.

Apart from the fact that the statement as made is of no practical value, because averages so made can be manipulated, the comparison is unfair to Scotland and Canada.

The U. S. gallon runs 42 to the barrel. The gallon used in Scotland and Canada runs only 35. Since the average given for Scotland is (though not so stated) the Scotch average in Imperial gallons and since it is improbable that the authors would use the Imperial gallon for the results obtained by them from United States shales, it is evident that the returns for Scotland and Canada should be increased by one-fifth in order to compare fairly with U. S. returns. This would make the returns from Scotland 27.6 U. S. gallons and from Canada 41.9 U. S. gallons.

Clause 6 in the general summary requires correction for the same reason. Clause 12 suggests that the writers have small knowledge of the industrial end of the oil question. As California, Texas and Mexican crude oils are different from the crude oils of Pennsylvania, so are the oils retorted from the shales of one deposit different from those of another. Oils from one bed are different from oils of another and the oils from the same shales will vary with retorting in different retorts. I wish to say also that the laboratory retort heated by the Bunsen burner is not satisfactory for precise work, which should be undertaken in retorts in which the heat control can be better governed.

LOUIS SIMPSON.

Ottawa, Can.

The Economic Position of Oil Shales

To the Editor of Chemical & Metallurgical Engineering

SIR:—The following addition should be made to our recent article on oil shales appearing in your issue for June 1, 1918, page 603:

To the section on the origin of petroleum should be added the highly interesting theory developed by Dr. Clifford Richardson¹ that "the origin of petroleum is to

¹Jour. Ind. and Eng. Chem. 8, 4, 1916; Met. and Chem. Eng. 16, 1917. (Jan. 1).

be attributed to the relation of surfaces and films of certain natural gases, either as a gas under pressure, at the levels where it exists, in a liquid state, to surfaces of solids, the oil 'sands' with which the former comes in contact." This theory seems to indicate that a highly catalytic and colloidal action takes place between the surfaces and films of certain natural gas to solid surfaces forming petroleum oil. The uniqueness of the theory has resulted from years of observation and experimental data along bituminous and natural gas lines, emanating from the Trinidad fields of which the latest gas samples show the constituents to be:

FROM SURFACE OF ASPHALT DEPOSIT²

	CH ₄	C ₂ H ₆	CO ₂	O ₂	N ₂	H ₂ S
Centre of Lake.....	85.1	4.1	9.8	0.0	1.0	0.0
Where gas bubbles issue violently from centre of lake.....	74.2	4.0	20.0	0.0	1.0	0.8
Where small bubbles issue gently from surface of water at centre of lake.....	64.7	4.7	26.3	0.0	2.7	1.6
* Ibid.						

It will be important to learn of Dr. Richardson's experimental verification of his theory, for with catalytic and colloidal phenomena playing their rôle in the origin of petroleum, the laboratory should speed nature's work and furnish us with bituminous material in measurable time from natural gas of certain composition. The results of Bardwell, Berryman, Brighton and Kuhre³ have been brought into question and the following data corrections noted. Samples of the hydrocarbons under discussion (by Dr. Richardson) were reanalysed by T. B. Brighton and by the N. Y. Testing Laboratory with the following results:

N.Y.T.L.	Trinidad Per Cent	Bermudes Per Cent	Tabbyite Per Cent
Bitumen soluble in CS ₂	56.9	92.5	94.7
Mineral Matter.....	35.6	5.1	4.8
Fixed Carbon.....	12.0	12.9	9.2
T. B. Brighton			
Bitumen soluble in CS ₂	57.5	92.3	...
Mineral matter.....	35.7	5.3	...
Fixed carbon.....			
N.Y.T.L.	Gilsonite	Wurzelite No. 1	Wurzelite No. 2
Bitumen soluble in CS ₂.....	...	...	...
Mineral Matter.....	...	...	...
Fixed Carbon.....	13.6	7.8	7.5

JAC C. MORRELL AND GUSTAV EGLOFF.

Organic Reagents for Research Purposes

To the Editor of Chemical & Metallurgical Engineering

SIR:—In order to provide for the supply of organic reagents for research and industrial purposes the Eastman Kodak Company has determined to commence their preparation in its research laboratory.

This decision was arrived at as a result of the articles published by Dr. Roger Adams and of a recent letter by Professor Gortner in *Science* (June 14, 1918, p. 590), which drew our attention to the need for an adequate supply of these materials produced by a firm of standing.

In order to carry on the work a separate section of the laboratory has been established under the title of the "Department of Synthetic Chemistry," which will be under the immediate direction of Dr. H. T. Clarke, well known for his publications on organic chemistry.

In order to make available to research laboratories in this country the organic chemicals which they require, it is proposed that chemicals for research work shall be supplied at the lowest possible price. At first, no doubt,

this price will necessarily be higher than that charged by the German firms before the war, but it is hoped that eventually the profit made on chemicals supplied for commercial purposes may enable the rarer materials made in small quantities for research work to be sold at a price which will be within the reach of all who require them.

At first, of course, the laboratory will be able to supply only a limited number of substances, and these in small amounts, but the department will be expanded to meet the demand and with the assistance of other laboratories interested in organic chemistry, and of the firms who are producing dyes and intermediates, it is hoped that after a time an adequate supply of synthetic organic reagents can be made available.

It is possible that laboratories may have in stock unusual reagents which they are unlikely to require. If any laboratories possessing such reagents will write to us we shall be glad to make an offer for the materials, thus making them available on the market.

Our thanks are due to many of the chief chemists of the country who have encouraged us to commence this work and especially to Professor Roger Adams for the way in which he has received our proposals and has assisted us by placing at our disposal the information as to this work which he has accumulated.

Communications regarding reagents should be addressed to the Research Laboratory, Eastman Kodak Company, Rochester, N. Y.

C. E. K. MEES.
Rochester, N. Y.

Conforming to the Prior Art in Flotation

To the Editor of Chemical & Metallurgical Engineering

SIR:—During the past fifteen months Mr. Parker C. Choate has made four communications to you¹, the last three dwelling particularly upon the equities involved in the Minerals Separation litigation.

It seems to me that Mr. Choate, as I read his communications, has a wrong impression as to the attitude assumed by those using oil in excess of Minerals Separation patent. He is apparently under the impression that the use of oil in excess of the patent is considered by them as "a new process." He says in his communication of May 1, 1917 (*Met. & Chem. Eng.* Vol. 16, page 469):

"They talk of a new process, yet perhaps there is no technical reason why more than 1 per cent of oil gives better results, but merely the commercial reason to avoid royalty payment to a capitalized patent interest that must be fought, right or wrong."

And again in his communication in the current issue, July 15, 1918 (*Chem. & Met. Eng.*, Vol. 19, page 60) he says:

"If it were shown by defendants that there was an advance in the art, or a new process discovered by the use of oil, in any way, in excess of a fraction of 1 per cent, then the ruling of the California Court would be understandable."

Mr. Choate appears to be under the impression that Minerals Separation holds the basic position, that they

¹March 1st, 1917, "Research and Industry," Vol. 16, page 244. May 1st, 1917, "Evasion of Patent Suit Decisions," Vol. 16, page 469. Oct. 15th, 1917, "Invention & the Flotation Suits," Vol. 17, page 452. July 15th, 1918, "The Recent Flotation Decision," Vol. 19, page 60.

²Ibid.

³Jour. Ind. and Eng. Chem. 5, 973, 1913, and 6, 865, 1914.

are the prior art. The fact is that the oil in excess of a fraction of 1 per cent was used by defendants to conform to the prior art and was frankly so stated. No claim whatever was made to "a new process" and there was no such "talk" by the defendant.

The court in San Francisco found no such distinction between efficient and non-efficient oils, as Judge Bourquin apparently injected into the patent. Everson had claimed oils and fats and fatty acids very broadly, and patent 835,120, of Minerals Separation, was no less broad as to the character of oil, simply claiming novelty as to quantity of oil used and manner and time of agitation.

Mr. Choate is absolutely wrong when he states that the decision of the Delaware court was sustained by the Supreme Court.

The U. S. Circuit Court of Appeals, in Philadelphia, reads the Supreme Court decision very differently from Mr. Choate. In the opinion of these judges the Supreme Court found the process of the patent to consist of an agitation greater than that of the prior art, in combination with a "critical" proportion of oil, and producing a froth different from that theretofore produced, whereas Judge Bradford had found that reduction in the quantity of oil of the process, as compared with the quantity of the prior art, was so great, as to in itself constitute invention.

R. C. CANBY.

Wallingford, Conn.

Metallurgy of Zinc

To the Editor of Chemical and Metallurgical Engineering

SIR:—Concerning the discussion along the same line as suggested in Mr. Parker C. Choate's contribution to the July 1 issue of the CHEMICAL & METALLURGICAL ENGINEERING, the interrogation arises: What are the fundamental problems in the retort metallurgy of zinc? They appear to be:

First, zinc sulphide must be desulphurized.

Second, zinc ore must be reduced to the metal at a temperature which is above the boiling point of the metal at ordinary pressure.

Third, the metal after reduction must be condensed to the liquid form. In so doing the very troublesome blue-powder is formed.

Making refined zinc is a different field, not being considered at present in the discussion. However, if the refined zinc is primarily or finally produced by retorting, the above three fundamental problems enter into its production.

Dismissing the subject of roasting as being a field by itself and not considering the lime-reduction process for the present, the subject resolves itself into the second and third problems, namely, reduction and condensation.

In regard to reduction in a furnace using vertical retorts mechanically fed and discharged, there could be no more difficulty than in the ordinary type of retort. An idea for changing the retort would be to have a central core connected with a plunger which would raise the retort out of the combustion chamber when a change was needed. The matter of briquetting could also be worked out for this type of retort. In the issue of METALLURGICAL & CHEMICAL ENGINEERING for June 1, 1916, was published a description with a cut of such a

furnace being operated in Germany. It would not be surprising if some such research had been conducted in Belgium before the war.

As to condensation and the formation of blue-powder using a vertical retort, the conditions would seem to be more favorable to success than with the continuous electrothermic furnace with which a great deal of trouble was experienced along this line, for small units would still be used.

From a theoretical standpoint the metallurgical difficulties arising in reduction and condensation would be fewer in the vertical than in the old style retort. The principal inventions would have to be in devices for feeding and discharging the retorts.

The best process is the most economical. The most economical is the one with the least cost as to labor, maintenance, and fuel. In choosing a process it is necessary to nicely balance the three items of cost, one against the other. If the vertical type of retort with mechanical equipment is adopted, the labor cost will be reduced and the maintenance cost will increase. But it is doubtful if the increase of upkeep cost will overbalance the decrease in labor cost. This is a natural trend in all industries, and it seems that the zinc smelters should be doing profitable research work along this line.

In regard to the third item of cost, fuel, a question arises whether it will be easier to conserve fuel in using the old retort process or the vertical retort and mechanical equipment. It would appear that the latter would be more favorable for the reduction of fuel expense, because to reduce the extraneous coal, gas must be burned in small burners and thus be better controlled. To do this there must be conditions that call for uniform heat continuously. This will also allow the gas formed in reduction of the charge to be recovered from the condenser and used for fuel, as the temperature being uniform at all times the furnace man will not need to leave the gas burning at the end of the condenser to show how the furnace is running by the way it "lights up."

The conclusions are that the continuous process with the use of vertical retorts and a mechanical equipment will reduce the labor and fuel expense and increase the maintenance, but that it will result in a cheaper process, since the reduction of the two items of expense will more than balance the increase in the one.

J. H. HASTINGS.

Donora, Pa.

Sugar Consumed by the Allies

The Food Administration has authorized publication of the annual statistics on sugar given below. It will be noted that America uses sixty per cent of this "human fuel" at a price very much below the average for Europe.

	Tons Consumption	Price	Value
United States.....	4,109,300	\$146	\$681,956,500
United Kingdom.....	1,565,600	252	394,531,000
France.....	570,600	246	140,372,766
Canada.....	352,200	166	58,465,200
Italy.....	277,000	526	145,667,300

The refiners now receive \$26 per ton for refining, which is perhaps the lowest rate for an equivalent amount of processing in the chemical industry. Large production makes this possible.

Western Chemical and Metallurgical Field

Tungsten Production, Imports and Requirements

AT THE conference held in San Francisco June 28 between the Tariff Commission and those interested in the production of tungsten, Mr. J. H. Mackenzie, of the Bureau of Mines, gave some interesting data on imports for 1917, together with data as to the origin and declared cost, c.i.f. New York. The imports of tungsten for 1917, figured to a basis of 60 per cent WO_3 , were:

Origin	Amount (Tons)	Cost per Unit
Hong Kong	32	
China, other than above	196	}\$11.60
Siam	28	
Japan	603	17.29
Mexico	340	8.70
Portugal	120	
Argentina	215	19.00
Chile	1,930	
Peru	1,200	
Panama	159	15.75
Ecuador	11	
Bolivia	45	
South Africa	1	
	4,880	

It was understood that the Chinese production came mostly from the interior; Japanese imports largely originated from Manchuria and Korea, and possibly were in part byproducts of other milling operations. Little information as to the origin of the Mexican importations was available, but on account of its low price, it was suggested that at least some of it represented loot acquired by Sonora bandits. The exports from the ports of Chile, Peru, Panama and Ecuador were largely of Bolivian origin, where much of the production is won from placers. Portugal produces about 3000 tons of concentrate yearly—probably 1000 tons of this is smuggled into Spain and thence into Germany as this amount seems to be lost to regular trade channels.

The three large producers of tungsten are Burma, Bolivia and the United States, each with about an equal volume. The entire Burmese output goes to England, which government has recently raised the price from 55 to 60 shillings, as the cost c.i.f. Liverpool is quoted at \$15.25 per unit. The Siamese and Burmese deposits are quite similar, and on account of proximity may be extensions of the same mineralized horizon. The tungsten is mainly brought in by Chinese and Japanese coolies who go into the interior and collect the rich surface ore running as high as 70 to 75 per cent WO_3 . The labor cost is very low—in the interior Chinese boys of 14 or 15 being had for about \$2.00 per month. The government tax is high, being from 30 to 40 per cent of the value, depending largely upon how many officials see it. Transportation and the sacks represent the balance of the importing cost, which would be from \$15.00 to \$17.00 per unit in the States.

Mr. Mackenzie also tabulated the United States production (basis 60 per cent WO_3):

	Tons
1908	671
1909	1,619
1910	1,821
1911	1,339
1912	1,330
1913	1,537
1914	990
1915	2,332
1916	5,849
1917	4,800 or a little more
1918	4,250 estimated

As shown, he thinks our probable production will be a little less this year than last, with greater imports.

The latter amounted to 595.5 tons per month for the first quarter of 1918, largely from South America, China and Japan, as compared to the monthly average of 400 tons in 1917. If production and importation is maintained at the above figures the available supplies of 60 per cent concentrates for 1918 will amount to 11,400 tons, against an estimated consumption of 11,975 tons.

Reports from sixteen large producers show their stock on hand as of May 1, 1917 and 1918, as follows:

	On Hand		
	May 1, 1917 Pounds	May 1, 1918 Pounds	Increase Per Cent
70 per cent ferro-tungsten	517,172	545,575	5
Ore and concentrates	1,134,379	2,370,219	52
High speed steel	3,555,257	5,269,958	33
The total equivalent to 60 per cent WO_3	3,690,720	5,757,640	36

The main use for this metal is in the manufacture of high-speed steels, for which there is no substitute known. Valve stems and seats for aeroplane engines bid fair to absorb a considerable tonnage. Probably other quantities are absorbed in gun tubes, although information as to such uses is naturally scarce. Molybdenum has often been spoken of as a substitute for tungsten; however, Taylor's original work condemned molybdenum as a constituent in high-speed steel, as has recent British and French ordnance tests. These results are possibly largely responsible for the present dull market in tungsten substitutes.

The Pacific Electro Metals Company

IT IS very natural for the Pacific Coast to become interested in electrometallurgy. The coastal regions, especially the California part, are well mineralized with various ores suitable for reduction in the electric furnace. Much hydro-electric power is already developed

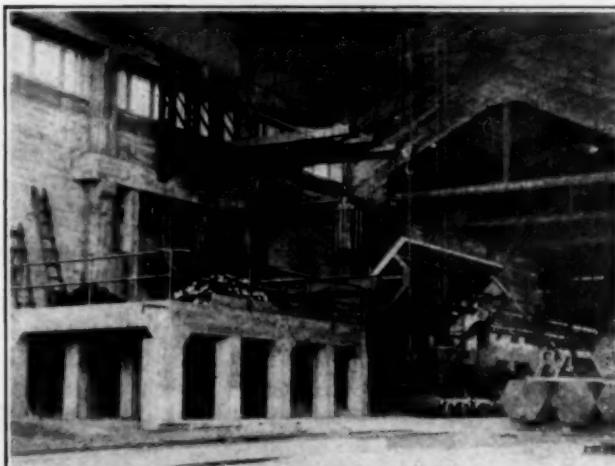


FIG. 1.—FERRO-SILICON FURNACE

and there are still large amounts of undeveloped power available comparatively close to tidewater. The Pacific Electro Metals Company has taken advantage of these conditions; the fact that it is being financed by a group of local men is an indication that the Pacific Coast is becoming awakened to the possibilities of new development aside from mining and agriculture. Its situation at Bay Point, Cal., is peculiarly fortunate in regard to transportation facilities, being served by two transcontinental railways as well as by deep-water navigation in Suisun Bay.

At the present time the furnace shown in Fig. 1 is in operation making a steel deoxidizer called silico-manganese of about the following analysis:

	Per Cent
Si	20 to 25
Mn	50 to 55
P	0.1
S	Trace
C	Less than 1, usually 0.5
Fe	Balance

The charge consists largely of a silicious ore of manganese, reduction being effected by the carbonaceous residue which was obtained from oil-gas works in the vicinity.

As shown in the illustration, the electric furnace is a three-phase furnace with an open top, lined with firebrick and carbon. Raw materials are kept heaped by shovel and rake around the electrodes, while the metal and slag are tapped at 2-hour intervals into sand beds formed in the car bodies, shown directly in front of the furnace. The operation of smelting is thus a continuous one. Transformer equipment for one furnace is composed of four single-phase, 1000-kw. transformers, one of which is a spare. The high tension current approximates a voltage of about 23,000, while the current fed to the furnace is in the neighborhood of 70 volts. The transformer room is a substantially built, reinforced-concrete addition immediately behind the furnace. Carbon electrodes are used and are 24 inches, round or hexagon. The holders are raised from time to time as the electrodes are consumed and the water-cooled clamps approach the ore charge, this operation consuming only about 10 minutes. Splicing being impracticable, the butt ends are reformed into the hexagonal electrodes stacked on the furnace room floor as in the illustration. This work is done in a well-equipped plant on the property. Much experimental work on a large scale has been done in this plant leading to the utilization of the gas-house carbon as a raw material for electrodes.

A second furnace of the same design is under construction in which ferro-manganese or silico-manganese will be made, according to the market. The furnace, transformer, packing and electrode buildings are all substantially built of concrete and impress the casual visitor very favorably. The site also contains warehouse, office, laboratory and other auxiliary buildings. The company has erected a colony of attractive cottages for their operators in the town of Bay Point.

Mr. J. Grotzinger is general superintendent of the company and in charge of the smelting operations. The plant was built during the last 12 months under the direction of the consulting engineers of the company, The Beckman & Linden Engineering Corporation of San Francisco, California.

American Smelting and Refining Company.—This company enjoyed a gross income of \$31,602,615 during the year ending Dec. 31, 1917, a record year, exceeding the maximum corresponding value by nearly three and one half millions. Net earnings applicable to dividends amounted to \$18,495,625 or 22½ per cent on common stock, after preferred dividends had been deducted. In the face of these returns, President Daniel Guggenheim notes that the peak price of metals was passed during the first half of the year, while costs of materials and labor are yet rising, and remarks: "By these two Governmental actions, first by reducing the value of our

product, and second, by constantly increasing our cost, this great corporation, producing what is absolutely necessary to the Government in carrying on the war, is having its ability to pay a fair return to its stockholders seriously jeopardized." During the year approximately \$4,700,000 was expended in extensions to smelters at Garfield, El Paso, and Hayden, and refineries at Baltimore, Perth Amboy and Tacoma, bringing the total capacity up to 1,150,000,000 pounds of electrolytic copper per year. An appropriation of \$6,000,000 was made for plant extensions and betterments during the year 1917, and the property account is now valued at \$136,797,476. During the year, the company added one more zinc plant to its operations located at Henryetta, Oklahoma. Poor railroad deliveries have resulted in a lock-up of values amounting to many million dollars, while severe weather and a shortage of labor have increased the difficulties of operation. Safety work costing \$160,000 has resulted in a 25 per cent decrease in the number of fatal accidents, a decrease of 451 disabling accidents, and a 5274-day decrease in time lost through temporary disability. The system of visiting nurses has been extended during the year, who visit workmen's homes, particularly in time of sickness, to instruct the mothers in the proper care of the family. Children's classes in sanitation and hygiene have also been organized.

OPERATING STATISTICS

	1916	1917
Number of men employees, excluding Mexico	21,073	24,698
Total wages and salaries, excluding Mexico	\$17,047,944	\$24,497,836
Average wages per 8-hour day	\$2.70	\$3.31
Tons charge smelted	4,789,474	5,918,924
Tons bullion refined	677,460	706,875
Tons coal used	724,595	787,890
Tons coke used	454,468	592,765
Barrels fuel oil used	1,107,285	1,560,535
Cubic feet gas used	2,130,460,528	3,032,908,373
Tons ore mined	1,638,566	2,318,925
Tons coal mined	244,807	259,499
Tons coke produced	140,961	186,107

METAL PRODUCTS

Ounces gold produced	2,662,011	2,496,693
Ounces silver produced	71,868,451	69,841,061
Ounces platinum and palladium produced	868	1,597
Tons lead produced	279,144	275,266
Pounds copper produced	789,438,000	848,888,000
Pounds best select copper produced	47,807,547	68,086,000
Pounds speiser produced	52,522,000	
Pounds nickel produced	1,224,328	682,715
Pounds tin produced	4,522,000	12,130,000
Pounds sulphuric acid produced	23,842,000	66,174,000
Pounds arsenic produced	9,090,000	9,132,000
Pounds copper sulphate produced	13,046,000	7,598,000
Pounds by-product metals	5,671,827	4,131,709
Pounds copper and brass manufactured products	31,597,489	39,767,274
Pounds test lead and litharge sold	417,898	426,472
Number loaded cartridges sold	15,338,000	14,180,000
Pounds sheet lead, pipe, etc., sold	21,713,331	13,678,245
Pounds mixed metals sold	2,831,617	5,188,045

Graphite Crucibles Placed on List of Restricted Imports

The War Trade Board has placed graphite crucibles upon the list of restricted imports. All outstanding licenses for the importation of graphite crucibles have been revoked as to ocean shipments after July 15, 1918, and no licenses for the importation of this commodity for shipment after that date will be granted for the rest of the calendar year. Imports of graphite are already prohibited, the result of this restriction having been to develop an adequate supply of graphite within the country. The action of the War Trade Board in restricting the importation of graphite crucibles is complementary to the restriction upon the importation of graphite.

Alien Property Custodian Seizes Metal Concerns

IT WAS announced on July 22 that the Alien Property Custodian had seized the property of L. Vogelstein & Co., Beer, Sondheimer & Co., and other minor organizations engaged in the metal industry. These were German-owned firms which exercised a large influence in the world's metal business. According to the Alien Property Custodian these firms had taken advantage of certain legal advice which had enabled them to masquerade as American firms so successfully that months of investigation were required to prove enemy ownership. Both of the seized corporations had made reports stating that they were American-owned, but apparently the Americanization was only a surface effect designed to hide German ownership. The following statement was issued by the Alien Property Custodian:

"With the American Metals Company, the large enemy interest in which has already been taken over by the Alien Property Custodian, Beer, Sondheimer & Co. and L. Vogelstein & Co. controlled most of the principal metal and smelting companies of this country, either by complete ownership of stock or by the ownership of enough stock to give them substantial representation on the Boards of Directors.

"Beer, Sondheimer & Co. own a one-half interest in the National Zinc Company, the entire stock of the Cuba Copper Company, the Cuba Copper Leasing Company, and the Norfolk Smelting Company, 30,000 shares of the Minerals Separation American Syndicate, Limited.

"Vogelstein & Co. have large holdings in the United States Metal Refining Company and the Kansas Zinc and Smelting Company. Of the 70,000 shares of capital stock of the American Metals Company, 15,180 shares are owned by the Metallbank and M. C. of Frankfurt-am-Main and 18,180 shares by the Metallgesellschaft of the same place.

"The American Metals Company completely owns the following companies: American Zinc and Chemical Company, Langeloth Coal Company, Langeloth Mercantile Company, Langeloth Townsite Company, American Metal Transport Company, Bartlesville Zinc Company, and South American Metal Company. It had large holdings of stock in the following companies: Ohio and Colorado Smelting and Refining Company, Compania Minera de Penoles, South America; Compania de Minerales y Metales, South America; Compania Metalurgica de Torreon, South America; Compania Minero Palome y Gabrillas, South America; Compania de Combustibbs Agujita, South America; Fundicion de Guaya- ca, South America; Balbach Smelting and Refining Company, and Nichols Copper Company.

"In 1914 the profits of Beer, Sondheimer & Co. were \$116,624; in 1915 the profits of this concern jumped to \$1,013,676, and in 1916 they reached the large total of \$2,000,000. In 1917, after the United States got into the war, the profits dropped to \$196,900.

"The profits of L. Vogelstein & Co. since April, 1916, were extremely large, the firm's business for the last three years approximating \$70,000,000 a year. Between April and December of 1916 the profits of Vogelstein & Co. amounted to upward of \$2,500,000.

"To make these concerns 100 per cent American, the Alien Property Custodian has appointed as Directors Americans who are well known in the business and financial life of the country.

"The Directors named for Vogelstein & Co. are:

EDWARD M. MCILVAINE, former President of the Bethlehem Steel Company.

LOUIS A. WATRES, President of the Scranton Trust Company and former Lieutenant Governor of Pennsylvania.

JAMES N. WALLACE, President of the Central Trust Company of New York.

ALFRED H. SMITH, President of the New York Board of Aldermen.

C. C. DANIELS of New York City.

"The Alien Property Custodian will allow Paul L. Vogelstein and Ernest Hetherin to act as Directors also; Isidor J. Kresel, 37 Wall Street, New York City, will act as counsel for this company.

"Messrs. Wallace, McIlvaine, and Watres will also act as Directors of Beer, Sondheimer & Co., in addition to John P. Greer, 15 Broad Street, New York City, and Ford Huntington, 15 Dey Street, New York City. Benno Elkan and Otto Frohknecht will act with the above Directors. Joseph E. Davies, former President of the Federal Trade Commission, and Isidor Kresel will act as counsel for this company.

DIRECTORS FOR AMERICAN METALS CO.

"The Directors whom the Alien Property Custodian has selected to represent the enemy interest in the American Metals Company are:

HENRY MORGENTHAU. Former Ambassador to Turkey.

ANDREW W. MALLON of Pittsburgh.

GEORGE MCANENY of New York City.

LEWIS L. CLARK of the American National Bank of New York.

E. C. CONVERSE of the Bankers Trust Company of New York.

"John J. Fitzgerald will act as counsel. Mr. Wallace, with Francis P. Garvin, have been chosen by the Alien Property Custodian to act as Directors for Stallforth & Co."

Government Controls Chlorine Production and Distribution

The War Industries Board authorizes the following: Owing to the shortage of chlorine in the United States, the War Industries Board, with the approval of the President, has passed a resolution taking over control of its production and distribution. For the present, however, the board is doing no more than allocate the product, and this is being done under the direction of H. G. Carrell, chief of the Alkali and Chlorine Section of the War Industries Board.

Chlorine has a wide range of uses, the most important from the present Government point of view being in the manufacture of gas shells and in carbon tetrachloride, which is the basis of one of the most effective smoke screens and also of the best fire extinguishers.

One of the most important commercial uses of chlorine is in the bleaching of paper and various cloth fabrics.

Platinum as Seen by the Jeweler and the Chemist

AT THE hearing with reference to the new revenue bill, held before the Committee on Ways and Means at Washington on July 10 and 11, the subject of platinum received considerable attention. It developed however, that most of the testimony resolved itself into a controversy between the jeweler and the chemist, rather than enlightening the Ways and Means Committee as to methods of deriving revenue by taxing platinum.

MR. MEYER C. ROTHSCHILD of New York City, representing sixty-two jewelry organizations in the United States, appeared before the committee on behalf of the jewelers. Much of his testimony was devoted to a reply to a speech made by the Honorable Henry T. Rainey, of the Committee on Ways and Means, on the floor of the House of Representatives on June 7. Mr. Rothschild felt that Mr. Rainey had put the jewelers in the wrong light before the country. He also felt that the campaign conducted by the American Chemical Society through the *Journal of Industrial and Engineering Chemistry* had misrepresented the platinum situation as far as jewelers were concerned with it. He stated that the Jewelers' War Service Committee had called on the War Industries Board at Washington, and had recommended that all unmanufactured platinum held by jewelers be commandeered. The War Industries Board, however, felt that this would seriously disturb the jewelry industry and consequently they commandeered 75 per cent of the stock of unmanufactured platinum in the hands of jewelers, after having been unsuccessful in getting the jewelers to give up their stock voluntarily. Mr. Rothschild took the position that the government should have commandeered platinum long before it did, taking no chances in regard to having an adequate supply. In cross examination of Mr. Rothschild, Congressman Longworth introduced a copy of a jewelry magazine showing full-page advertisements in which platinum jewelry was featured. The advertisements were cited as an example of what had not been accomplished in the direction of preventing advertisements of platinum jewelry.

Whatever may be the merits or the demerits of the jewelers' attitude, Mr. Rothschild made some remarks in regard to the attitude of the War Industries Board in fixing a price of \$90 per ounce for platinum when it was selling in the open market in New York at \$105.

Mr. Rothschild pointed out that but for the unbusinesslike attitude of the War Industries Board, the United States might easily have secured additional platinum supplies from Russia. This, however, was impossible when a price of but \$90 per ounce was paid for some 21,000 ounces which was brought over here at great risk. Mr. Rothschild was of the opinion that there was about one million ounces of platinum now in the country, of which the jewelers held a stock of about 5000 ounces on February 1, 1918.

DR. CHAS. H. HERTY, editor of the *Journal of Industrial Engineering Chemistry* appeared before the committee to correct certain erroneous impressions which he felt were created by Mr. Rothschild. Doctor Herty pointed out particularly that the movement started by the American Chemical Society for the conservation of platinum was not a propaganda on the part of a few

chemists, but the action of an important organization embracing about 12,000 chemists in every part of the country. Doctor Herty showed the essential nature of platinum in the chemical industry and its unessential use in jewelry, particularly in war time, and defended very well his entire editorial campaign against such use of the metal.

On the question of taxation of platinum, it was Dr. Herty's opinion that there should be none of the metal available for taxation; that the Government should purchase the entire supply in this country and place it in the vaults of the Treasury for Government needs. He pointed out that there was a great deal of manufactured platinum jewelry in this country today, which could easily be bought by pro-German interests and transmitted to Germany in a round-about way.

DR. LOUIS J. WEINSTEIN of the Dental Department of Columbia University, also appeared before the Ways and Means Committee, with regard to the use of platinum in the dental business. He was of the opinion that the dentists of the United States use about 20,000 ounces of platinum per year, but that this quantity could be reduced very materially through the use of substitutes. He felt that on a request coming from an authoritative source, the use of platinum could be cut down so that only one-fourth of the customary amount would be used in dentistry, which would release about 15,000 ounces per year for other purposes.

MR. LELAND L. SUMMERS of the War Industries Board appeared before the Committee to refute the inference carried by previous testimony that the War Industries Board "has been incompetent and asleep, and that the military program of the Government has been imperiled" thereby.

Mr. Summers explained the Board's policy in fixing \$90 per ounce as the price to be paid for the 21,000 oz. of Russian platinum by saying that the British Government official price was only \$65 per oz. and that our Government commandeered the Russian lot at \$90 with the understanding that those who had furnished the platinum could go before the Court of Claims or the Board of Appraisers and get more if they could show that \$90 was not a fair price.

Mr. Summers upset all previous testimony by saying that the agitation about platinum has been overdone; that he was not distressed as to where the platinum is coming from; and that substitutes could be used just as they have been elsewhere. He stated emphatically that "we are not up against any crisis." The War Industries Board now controls 40,000 oz. of platinum, and apparent requirements on March 1, 1918 were 37,000 oz. and today about 55,000 oz. The apparent shortage can be provided by supplies from Colombia, 10,000 oz. from Great Britain, and by extending the commandeering orders not only to the jewelry trade but also to the dental and chemical professions. With regard to substitutes for platinum for making sulphuric acid, Mr. Summers stated that "we are getting very satisfactory results from preliminary experiments that have been undertaken."

With regard to further extension of the commandeering orders, Mr. Summers said that by including the chemical and dental industries and the balance of the jewelers, provision would be made for our requirements well into 1920.

New Government Agency Taking Census of Industries

To meet the constantly increasing demands of the Government for new resources and to supply the War needs of the Army and Navy and other Government departments, the War Industries Board has created the Resources and Conversion Section.

The primary object of this new section is to assemble as quickly as possible complete and detailed information concerning industries in all parts of the country:

(a) Those not now engaged in war work but capable of undertaking such work.

(b) Concerning industries only partly employed on war work but able to increase their production of necessary war materials, and

(c) Industries now employed on war work whose contracts will soon be complete.

To accomplish this in the most efficient way it has been decided to divide the country into regions and organize them thoroughly under the leadership and with the co-operation of the local Chambers of Commerce and other business men's organizations.

It is desired to enlist the aid of all classes of industry, and to bring this about it is imperative that all



UNITED STATES INDUSTRIAL REGIONS

the industries of a given region should be asked to participate whether they are now members of business organizations or not.

The twenty regions and the regional representatives appointed are:

Region No.	Region	Name
1	Boston	Stuart W. Webb
2	Bridgeport	B. D. Pierce, Jr.
3	New York	Wm. F. Morgan
4	Philadelphia	Ernest T. Trigg
5	Pittsburgh	George S. Oliver
6	Rochester	Eaton A. Fletcher
7	Cleveland	Wm. B. McAllister
8	Detroit	A. H. Templeton
9	Chicago	D. E. Felt
10	Cincinnati	Edwin C. Gibbs
11	Baltimore	
12	Atlanta	
13	Birmingham	T. H. Aldrich
14	Kansas City	F. D. Crabbe
15	St. Louis	Jackson Johnson
16	St. Paul	
17	Milwaukee	August H. Vogel
18	Dallas	Louis Lipsitz
19	San Francisco	Frederick J. Koster
20	Seattle	

As an indication of what is possible in the conversion of industry to meet war requirements and of the changes which can be made in the product of a factory, a few radical instances serve to illustrate. For instance, a Pennsylvania factory that formerly made linoleum is now machining 4.7-inch shells. A Duluth horseshoe manufacturer is turning out trench picks for the Army, and a New Jersey terra-cotta tile concern is making dummy drop bombs. A Milwaukee factory, the former output of which was rowboat motors, is making hand grenades and trench pumps. In Rhode Island, a manufacturer of finger rings has returned his activities to making adapter plugs. A Detroit stove concern is producing trench bombs and anchor parts, and a New York shirtwaist manufacturer is making signal flags.

Corporation Organized to Sell Enemy-Owned Property

The formation of a selling corporation to control and sell all German-owned corporations taken over by the Alien Property Custodian has been announced at Washington. This selling corporation will have complete control over the sale of nearly 150 enemy-owned corporations now in the custody of the Alien Property Custodian, valued at about \$250,000,000. In addition to the Alien Property Custodian the new selling organization will consist of a Washington committee, an advisory committee in New York, a sales manager in New York, representatives of the Alien Property Custodian in charge of each property to be sold, and an attorney representing the Alien Property Custodian in respect of each property to be sold. Sales will be made at public auction whenever it is possible to do so, and unless the Advisory Committee recommends different procedure. This applies not only to sales by the Alien Property Custodian, but also to sales by and in the name of

corporations controlled by him. The expenses of each sale, which shall include all expenses and costs of every kind, shall be paid out of the funds of the specific property sold, or out of the purchase money received from such sale, or deducted from the purchase price.

Instruction and Research in Industrial Hygiene at the Harvard Medical School

Through the foresight and generosity of a group of New England manufacturers, who appreciated the importance of studying the diseases peculiar to factory labor, special courses have been arranged, which will be given in the School of Public Health. Those properly qualified may matriculate for the degree of Doctor of Public Health (Dr. P.H.). For information apply to Dr. C. K. Drinker, Harvard Medical School, Boston, Mass.

Distribution of Niagara Power

INTERVENTION by the United States in the control and distribution of power generated in this country in the Niagara Falls district and that imported from Canada has resulted in accurate knowledge of the uses of that power. In a report recently made to Secretary Baker by Brig. Gen. Charles Keller and Robert J. Bulkley, it is shown that practically all the power available is used to the advantage of the prosecution of the war, as appears in Table I.

TABLE I—THE USAGE OF ELECTRIC ENERGY AS PRODUCED DURING A TYPICAL PERIOD IN THE WINTER OF 1917-1918

Niagara Falls Power Co.	Niagara, Lockport & Buffalo			
	Hydraulic Power Co.	Ontario Power Co.	Niagara & Erie Power Co.	General Electric Co.
	Percentage of Total Output			
Direct war industries.....	73.53	97.05	58.31	50.27
Transportation purposes...	11.55	.....	21.21	21.47
Street, commercial and residence lighting, water supply.....	7.81	1.95	7.61	13.99
Commercial power consumers over 100 H.P.	1.52	0.13	5.94	2.82
Small commercial power....	3.61	0.78	6.80	7.49
Non-essential purposes....	1.98	0.09	0.13	3.96

Table II shows not only the increased allotments of power to the essential electrochemical industries in the Niagara district, but also the average amounts of

TABLE II—NIAGARA FALLS—BUFFALO DISTRICT INCREASED ALLOTMENTS OF POWER TO ELECTROCHEMICAL INDUSTRIES IN APRIL 1918, AS COMPARED WITH POWER USED IN NOVEMBER, 1917, UNDER NORMAL CONDITIONS

Product Manufacturer	Ferro-silicon Nov., '17-Apr., '18		Electrodes Nov., '17-Apr., '18		Silicon Nov., '17-Apr., '18		Phosphorus, Etc. Sodium-Cyanide Nov., '17-Apr., '18		Chlorine, Etc. Nov., '17-Apr., '18	
	Hp.	Hp.	Hp.	Hp.	Hp.	Hp.	Hp.	Hp.	Hp.	Hp.
Union Carbide Co.	66,867	78,964	Hydraulic Power Co. Niagara Falls Power Co. Niagara, Lockport & Ontario Power Co.							
Defiance Paper Co.		2,034 ¹	Hydraulic Power Co. Niagara Falls Power Co.							
International Paper Co.		3,000 ¹	Hydraulic Power Co. Niagara Falls Power Co.							
U. S. Alloys Company.	6,720	9,176	Buffalo General Electric Co.							
Increase.....	73,587	93,174								
National Carbon Company.....		19,587								
Int. Ach. Graphite Co.			2,577	4,761						
Star Electrode Works.			5,408	7,908						
			4,083	5,683						
Increase.....			12,068	18,352						
Carborundum Co. of America.					10,483	12,700				
Increase.....						2,217				
Oldbury Electrochem. Co.							5,634	8,654		
Increase.....								3,000		
Niagara Electrochem. Co.							9,506	13,506		
Increase.....									4,000	
Mathieson Alk. Co.										10,343
Iaco Chemical Co.										1,300
Niagara Alkali Co.										7,077
Niagara Smelting Co.										1,125
Increase.....										3,139
Total increase.....										19,845
										22,346
										2,501
										37,589

¹ Used by Union Carbide Co. until Apr., when Paper Co. began Ferrosilicon manufacture. ² Power supplied by Niagara, Lockport & Ontario Power Co.

power in use before January 1, 1918, and the average amounts now devoted to the production of such es-

TABLE III—DISTRIBUTION OF ELECTRIC POWER OF THE HYDRAULIC POWER COMPANY OF NIAGARA FALLS BEFORE AND AFTER APPLICATION OF ORDER OF THE SECRETARY OF WAR, DECEMBER 28

Name of Company Taking Power	Use of Reapportionment of Distribution Power				March, '18
	Power, Nov., '17	Increase	Power, Nov., '18	Decrease	
Hp.	Hp.	Hp.	Hp.	Hp.	Hp.
Aluminum Company of America.	65,866	.....	6,000	59,866	
Ice Companies.....	473	.....	223	250	
Cliff Paper Co.	3,291	.....	3,291	0	
Defiance Paper Co.	2,034	.....	2,034 ¹	0	
Frontier Brick Co.	36	.....	36	0	
General Abrasive Co.	1,706	.....	1,706		
Nat'l Electrolytic Co.	2,892	.....	2,892		
Union Carbide Co.	37,000	5,300	.....	42,500	
Hooker Electrochemical Co.	6,534	.....	6,534		
Iaco Chemical Co.	591	600	.....	1,191	
National Carbon Co.	2,477	2,184	.....	4,761	
Niagara Alkali Co.	5,714	300	.....	6,014	
Oldbury Electrochemical Co.	3,000	3,000	.....	6,000	
U. S. Light & Heat Corp.	1,319	.....	1,319		
Titanium Alloy Mfg. Co.	7,074	.....	7,074		
Other smaller companies.....	4,514	.....	4,514		
	144,621	11,584	11,584	144,621	

¹ Later returned to Paper Company when it began manufacture of ferrosilicon.

sentials as ferrosilicon, electrodes, phosphorus, chlorine, and abrasives.

TABLE IV—DISTRIBUTION OF ELECTRIC POWER OF THE NIAGARA FALLS POWER COMPANY OF NIAGARA FALLS BEFORE AND AFTER APPLICATION OF ORDER OF THE SECRETARY OF WAR, DECEMBER 28

Name of Company Taking Power	Use of Power, Nov., '17	Increase	Reapportionment of Power, Nov., '18	Decrease	Distribution of Power, Mar., '18
Hp.	Hp.	Hp.	Hp.	Hp.	Hp.
Buffalo General Electric Co.	35,282	.....	9,100	26,182	
Niagara River Mfg. Co.	880	.....	880	0	
International Paper Co.	3,000	.....	3,000 ¹	0	
Acheson Graphite Co.	5,408	2,500	.....	7,908	
Hooker Electrochemical Co.	9,165	.....	9,165		
Iaco Chemical Co.	709	.....	709		
Mathieson Alkali Co.	10,343	1,407	.....	11,750	
Niagara Electrochemical Co.	9,506	4,000	.....	13,506	
Niagara Alkali Co.	1,363	.....	1,363		
Oldbury Electrochemical Co.	2,654	.....	2,654		
Star Electrode Works.	4,083	.....	4,083		
Carborundum Co.	10,483	2,217	.....	12,700	
Union Carbide Co.	16,533	1,256	.....	17,789	
Other smaller companies.....	23,935	.....	23,935		
	133,344	12,980	12,980	133,344	

¹ Later returned to Paper Company when it began manufacture of ferrosilicon.

Mining Engineers Meet in Colorado in September

The American Institute of Mining Engineers will hold its regular Fall meeting in Colorado during the week of Sept. 2. The sessions will open in Denver on Sept. 2, after which headquarters will be at Colorado Springs.

Trips will be made from that point to the Cripple Creek district, Pueblo, Leadville district and Boulder. The sections to be visited are rich in important war minerals and important in the manufacture of ferro-alloys. The committee in charge of the meeting comprises: Spencer Penrose, chairman; A. E. Carlton, chairman finance committee; George M. Taylor, vice-chairman; J. Dawson Hawkins, secretary. Denver committees: (Arrangement) Dave G. Miller, Frank Bulkley, Geo. E. Collins; (Entertainment) F. H. Bostwick, F. E. Shepard, Howland Bancroft, B. P. Morse, J. G. Perry; (Finance) T. B. Stearns, Richard A. Parker, T. B. Burbridge.

On July 1 670 officers and employees of H. M. Byllesby & Company and affiliated companies were engaged in the military service of the United States or Allies. This represents 13.8 per cent of all male employees. The service flag now bears four gold stars.

The Metallography and Heat Treatment of Metals Used in Aëroplane Construction

Introduction to a Series of Articles Dealing With Cast Iron, Steel, Aluminium, Copper, Bronze, and Brass—Typical Examples of Investigations of Aëroplane Parts, With Microphotographs and Results of Physical and Chemical Tests

BY F. GROTTES

Chief Metallurgist, Curtiss Aëroplane and Motor Corporation.

THE metals that are used in aëroplane construction are aluminium, copper, bronze, brass, cast iron and steel. Of these, steel has the most importance as more and important parts are made from it than from any of the other metals. It is divided into two classes, (a) carbon steel and (b) carbon steel to which has been added some particular element (Ni, Cr, Va, etc.). The first division, carbon steel, is subdivided into low (0.15 per cent C), medium (0.32 per cent C) and high (0.9 per cent C); while the second division includes the nickel, chrome, vanadium, chrome-nickel and chrome-vanadium steels.

The structure and physical properties of these metals are greatly affected by the treatment or treatments, both mechanical and thermal, to which they have been subjected at the time of manufacture or after. As the structure and physical properties are of supreme importance it is necessary that they be investigated. This is done by certain tests, the best of which is a test to destruction, but this method is too expensive and time-consuming. Sometimes a practical field test will give all of the data necessary, but in order to judge whether or not a metal is suitable for the purpose for which it was intended, separate parts of the material are selected for test, and upon the results of these tests the metal is judged as a whole.

Chemical and physical tests give satisfactory data within certain limits, but they should be supplemented by metallographic tests which give information not obtainable by any other method. The particular use of metallographic testing is to give information in regard to the homogeneity of the metal, the heat treatment to which it has been subjected, and whether it has been subject to any strains.

METHODS AND APPARATUS USED IN TESTING

In taking up the metallography and heat treatment of the materials before mentioned, the methods and apparatus will first be discussed.

Preparation of Samples. The samples used for metallographic examination are about one-half inch square or round. They are cut in most cases with a hacksaw, but hardened materials are cut with an emery wheel to the required size. Where the samples are too small to hold it is necessary to polish out to their edge; they are mounted in a section of tubing with solder or other low melting-point material. The tubing is about one-half inch long and one-half inch in diameter. The part to be mounted is placed in the center and the solder poured in the tube around it. This holds the specimen firmly and a good polish results.

Polishing. After taking the sample, all rough edges are removed with a file or emery cloth after which the section is ground down progressively from a coarse to fine emery belt and then, starting with No. 0 polishing paper, to No. 0000. At this point it is carefully examined to see if all scratches are removed; if so it is placed on a buffer covered with cloth and on which is placed some alumina and water. After this the specimen should be ready for the microscope.

Rules for Polishing

1. Never overheat specimen and use light pressure.
2. Prevent the surface from becoming convex.
3. Turn specimen through 90 deg. after each separate operation and polish in the same direction during each operation.
4. Continue each step only long enough to eliminate the scratches of the previous operation.
5. Wash the specimens thoroughly between each operation to prevent particles of one abrasive from becoming mixed with the next and finer abrasive.
6. Keep all apparatus and solutions covered when not in operation. Fine particles, dust, sand, emery, etc., will spoil a half-day's work.
7. Use light pressure for aluminium, brass, bronze, etc., and in finishing on the buffer twist the specimen now and then to prevent smears or streaks in the direction of polishing.

Etching. Clean the section carefully with warm water and dry with alcohol. Immerse in the chosen solution for five seconds, ten seconds, etc., until etched properly. Clean with hot water and dry with alcohol. If the specimen is covered with a film, rub carefully on buffer and clean with alcohol. Etching solutions have the following composition: Nitric acid solutions of 10 cc. HNO₃ in 90 cc. alcohol and 20 cc. HNO₃ in 80 cc. alcohol are used. These solutions give good results but are not so good to show the structure for all steels in general as the following picric acid solution.

Picric acid: Saturated solution or about 10 grams of picric acid in 90 cc. of alcohol.

Sodium picrate: Two grams of picric acid is dissolved in 98 cc. of a solution of 250 grams of NH₄OH in 750 cc. of water. After boiling the polished specimen in this solution for 10 minutes, the ferrite remains bright while the cementite is dark colored.

Iodine: Tincture of iodine for copper, brass and aluminium, also to show strains in steel.

Copper ammonium chloride: For bronze and brass; 10 g. copper ammonium chloride, 15 cc. concentrated ammonium hydroxide, 250 cc. water.

Heat Tinting. Heat slowly until the specimen is colored yellow-brown, when the parts high in phosphorus will appear purple or blue.

Sulphur Printing. Velox printing paper soaked in a 3 per cent solution of sulphuric acid or 10 per cent hydrochloric acid solution is placed on the specimen for 20 seconds, washed in water and then fixed in hypo as are other prints. Sulphur shows black, due to the H_2S given off from the reaction of the acid on the sulphide in the specimen. Care is taken to prevent specimen from slipping during printing operation.

PHOTOMICROGRAPHY

After polishing, the specimens are examined for slag, manganese, sulphide or pipes. The slag shows as dark irregular masses, the manganese sulphide as dove-colored oval-shaped bodies and the pipes as shown in Fig. 1.

After selecting the spot to be photographed, adjust the light carefully so as to get as bright and even

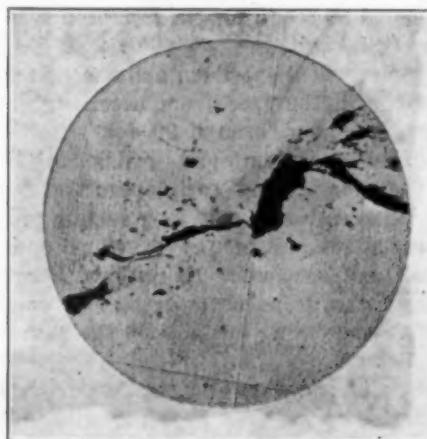


FIG. 1

illumination as possible. Focus the image as sharp as possible with the coarse adjustment and then finish with the fine adjustment.

Exposure. After the image is properly illuminated and focused, the plate is introduced and exposed. The length of exposure varies according to kind of plate, polish of specimen, power of illumination and color of screen (green, red, etc.). The plates used are panchromatic and Wratten "M" plates with green screen and electric arc illumination. The panchromatic plates are exposed for 15 seconds with the small orifice and the "M" plates for the same time with the next larger orifice.

Development. These plates are handled in an absolutely dark room and are developed for 15 minutes in Eastman developing powders 2½-3½-A-4 at a temperature of 65 deg., washed in cold water and immersed in fixing solution for 15 minutes.

Stock fixing solution.....	384 oz., H_2O	A
	96 oz., Hypo	
	30 oz., H_2O	
	6 oz., Na_2S	
	18 oz., Acetic acid	B
	6 oz., Alum	

Add B to A slowly and stir vigorously.

After fixing, the plates are washed in running water for twenty minutes, then dried in a current of air.

Printing Papers. Velox regular glossy is used, printed for the necessary time to get the desired result, developed in solution of Eastman MQ developer at a temperature of 70 deg., washed in water and fixed in stock fixing solution for 15 minutes and then washed in running water for 20 minutes.

Drying Papers. A ferrotypic tin is used which is first washed with water and dried with alcohol and then covered with a solution of beeswax in benzol. After drying, the surface of the tin is polished and the papers placed on it and rolled smooth. All moisture is removed with a blotting paper after which an electric fan soon dries the prints which drop from the tin and can be cut to the proper size and mounted.

HEAT TREATING

The object of heat treating is, first, to remove any stresses that might exist in the material; second, to refine and improve the structure; third, to cause a change in order to get the required physical properties. To understand these objects it is necessary to have considerable knowledge of the nature and composition of the metallic alloys. This is essential to an intelligent microscopic examination and heat treatment of any specimen of steel.

Steel is an alloy of various elements, the most important of which are carbon and iron. They go into solution at a high temperature while on cooling the constituents crystallize out in the form of octahedrons which have three cleavage planes showing in martensite.

In the heating and cooling of steel, certain phenomena are observed. For illustration; at one point, the steel becomes magnetic, and at another it seems to gain heat on cooling and actually glows. These points are called critical points and are shown by plotting cooling and heating curves.

Critical Points. In order to determine the proper heat-treating points, temperature curves are plotted which show the critical range. An easy method of procedure and accurate enough for most purposes is to take pieces of the material and place them firmly about a thermocouple in a furnace. As the heat rises, temperature readings are taken about every 10 seconds up to 1700 deg. F., which will take care of most steels. Plot the curve time and temperature, both heating and cooling. The material is quenched at about 100 deg. F. above the large break in the curve.

Where more accurate data are required, there is used a neutral body and a double thermocouple so connected that the difference of temperature between the metal under investigation and the neutral body is recorded as well as the actual temperature of the metal. This shows the critical range and whether there are one, two or three critical points. To distinguish critical points on cooling from those occurring on heating, the former are called Ar (from the French *refroidissement*, meaning cooling) and the latter Ac (from the French *chauffage*, heating). The points on heating are designated Ac_1 , Ac_2 , Ac_3 , and on cooling as Ar_1 , Ar_2 , Ar_3 .

The Ar_1 points in the carbon steels used occur between 1250 and 1350 deg., and Ac_1 points about 75 to 100 deg. higher (all temperatures Fahrenheit). The critical points on cooling always lag behind the points on heating.

The critical points are due chiefly, if not wholly, to allotropic changes of the iron; and their great importance is due to the fact that the color, crystallization, dilation, conductivity for heat and electricity, strength, ductility, hardness and specific gravity of the steel are affected while passing through them.

There are three allotropic forms of iron: alpha, beta and gamma. Below the A_1 point it is known as alpha which is magnetic, soft, and will not take any carbide into solution; between the A_1 and A_3 points is beta which dissolves carbide, is non-magnetic and harder than alpha iron. Above A_3 is gamma which also dissolves carbide, is very hard and non-magnetic. The addition of different elements will influence the critical points. Manganese and nickel lower the critical points. Silicon and phosphorus go into solid solution with the ferrite and have no appreciable effect. Chromium and tungsten raise the critical temperatures and vanadium has no marked effect.

ANNEALING, HARDENING AND DRAWING OF STEEL

Steels are divided according to their carbon content into three classes: hypoeutectoid, below 0.89 per cent carbon; eutectoid, at 0.89 per cent; and hypereutectoid, above 0.89 per cent. The hypoeutectic class will cover most of the aeroplane steels. The medium carbon steel is a good illustration.

This material is generally in an annealed condition to start with, or a mixture of ferrite and pearlite. As heat is applied and the steel passes the A_1 point, the constituents go into a solid solution consisting of iron carbide, cementite or a double carbide of iron and the special element (Cr, Va) in gamma iron. If this is quenched in salt water or other abrupt medium, it is called austenite, but if quenched in oil, probably martensite, which is a more stable form resulting from the austenite giving way along its cleavage planes. On heating or drawing martensite, there is a slight precipitation of ferrite or beta iron. This mixture consisting of beta iron and a solid solution of carbide in gamma iron is called troosite which becomes sorbite on further drawing or on a further precipitation of beta iron. At the Ac_1 point the beta iron is converted into alpha iron and on the drawing being continued the gamma solution approaches the eutectic until at the Ac_3 point it is converted into pearlite. The mixture now consists of ferrite and pearlite.

Annealing. The object of annealing is to relieve strains and to soften the structure or make it normal. It consists in raising the steel to a temperature above the Ac_1 point and holding it a sufficient time to get a complete solid solution. Then allowing it to cool slowly in the furnace in order that all transformation may be completed—austenite, martensite, troosite, sorbite and ending with a mixture of ferrite and pearlite. This is a furnace or soft anneal.

Most annealing or better normalizing is done by merely heating past the Ac_1 point and then cooling in air. This gives a mixture of ferrite and sorbite instead of ferrite and pearlite as results in furnace cooling. If a fine structure is wanted coincidentally in a good soft material, quench at above the Ac_1 point and draw at just below the Ac_3 point.

Quenching. Materials are quenched in order to get

maximum hardness and grain refinement. It consists in heating the steel past its Ac_3 point and quenching in oil or water. This retains it in its austenitic and martensitic condition which is very hard and fine. See Fig. 2.

Drawing. Drawing consists in heating to some point below Ac_1 and cooling in air or oil. This is a softening or toughening process in which ferrite is liberated varying with the increase of draw. Practically all of these steels on being drawn are sorbitic, as shown in Fig. 3.

Grain Size. Care should be exercised in not passing the upper critical too far, as the grain size grows accordingly and there is danger of overheating.

Overheating. This causes a very coarse structure but it can be restored by merely heating to a little above the critical (upper) point and quenching. Overheating should not be confounded with burning. Compare Figs. 4 and 5.

Burning. Burnt steel is brittle and its fracture is coarse and shiny. Material that has been burnt is of no value in this work.

Test Specimens. All specimens that are heat-treated for test purposes are carefully machined to the required shape and size, then treated in electric or oil furnaces. Much attention should be paid to the machining of specimens, as an extra deep cut will spoil the test. This often occurs near the shoulder. The data from a poor specimen are of no value.

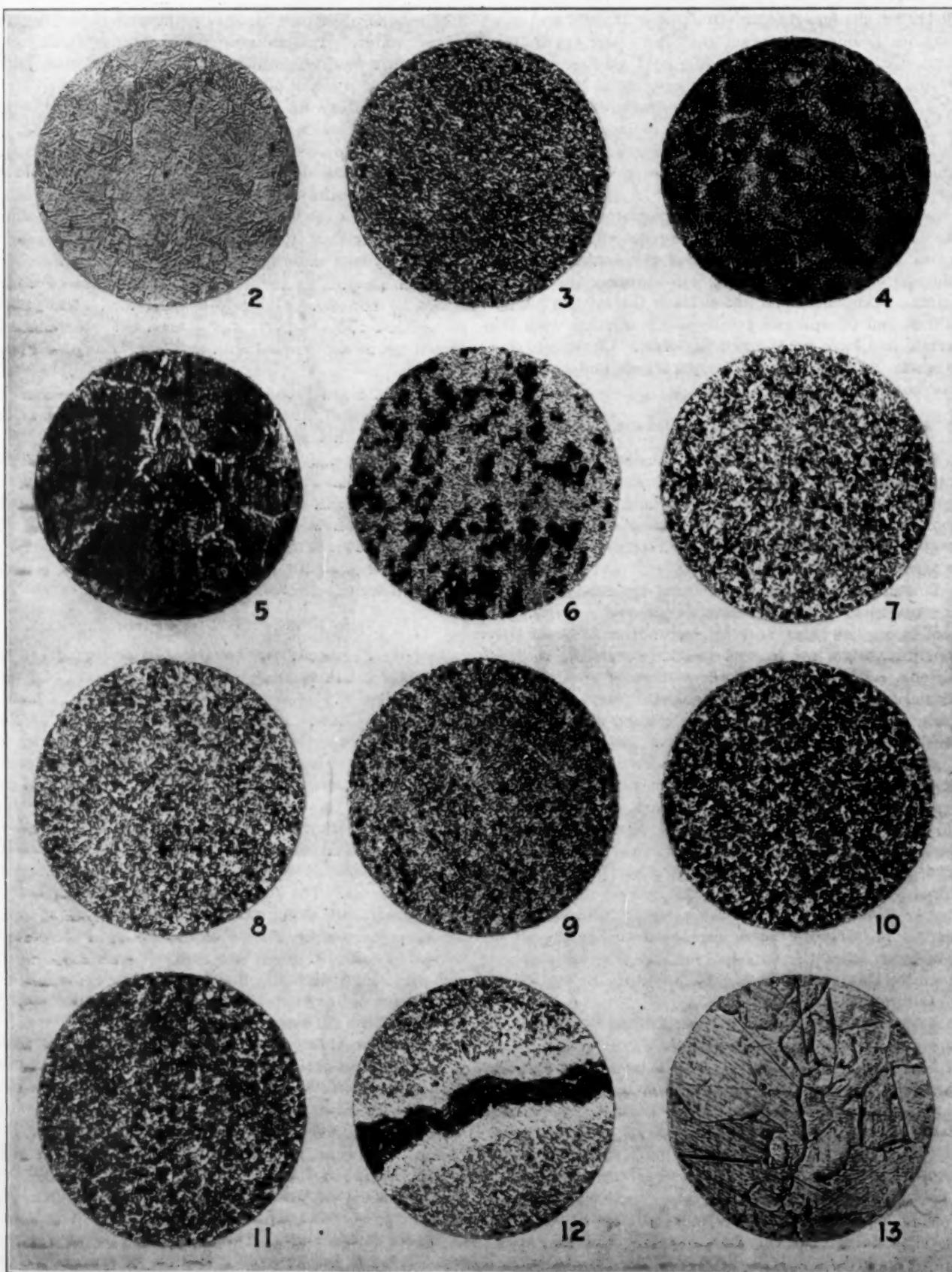
FURNACES AND PYROMETERS

Electric Furnaces. The electric furnaces used are of Hoskins manufacture and give a good even heat up to 2000 deg. F. They are especially adapted to heavy duty or continuous operation and are capable of 24-hour-per-day service. The heating units of chromel in the shape of hair pins can be easily removed and replaced in a short time in case they are burned through. They operate on low voltage (10 to 57.5 volts) for which reason they are best adapted for use on alternating-current circuits in connection with a transformer. It takes about two hours to reach 1800 deg. F. from a cold furnace. The thermocouple enters at the center of the rear. In order that the material treated may be nearer the couple, a piece of sheet steel or secondary bottom is inserted. This is placed on small supports of sufficient height to bring the sheet within a distance of two inches of the couple. This sheet will also prolong the life of the furnace lining.

The atmosphere is oxidizing, so that at high temperatures care must be exercised to prevent excessive scale. It is sometimes necessary to inclose the samples in boxes or tubes in which has been placed some oil, kerosene, etc. The covers are sealed with fire clay.

Where a specimen is to be quenched at say 1500 deg. F. the furnace is slowly brought up from 1000 deg. F. over a period of about 30 minutes to 1500 deg. F. At this point the temperature is held for 10 minutes to insure good results. The sample should be rapidly transferred to the quenching medium to prevent undue oxidation and decrease in temperature.

Quenching Mediums. Kerosene, fish oil, wool oil with a mineral oil base, warm water, salt water, soapy water, a layer of oil on water. The kerosene is used for high-speed tools, tungsten, etc.; fish oil or wool oil for prac-



FIGS. 2-13

Fig. 2—Effect of Quenching. Fig. 3—Effect of Drawing. Fig. 4—Effect of Overheating. Fig. 5—Effect of Burning. Figs. 6-11—Low Carbon Steel. Analysis: C, 0.20%; Mn, 0.50%; S, 0.60%; P, 0.045%. Etched with picric acid. $\times 100$. Fig. 6, annealed; 7, quenched; 8, quenched and drawn at 800 deg. C.; 9, quenched and drawn at 1000 deg. C.; 10, quenched and drawn at 1300 deg. C.; 11, raw stock. Fig. 12.—Seam in Tubing; $\times 100$. Fig. 13—Decarbonized Area in Tubing; $\times 100$.

tically all steels where toughness and hardness are needed; warm water for high carbon tools to prevent cracking; salt water to give extra hardness; soapy water for a less rigid quench than warm water; and oil on water to ease the rigid quench of the water.

Drawing. Heat the specimen slowly to the required temperature, hold for 30 minutes, varying time according to the size, shape, etc., of specimen; then remove and cool in still air. Do not lay on cold steel as there will be inequality of cooling.

Oil Furnaces. In most cases the time should be lengthened for holding the pieces to be heat-treated over that of the small electric furnaces. When the parts are inclosed in boxes it should take at least three to five hours to get the necessary results. The size of the material varies the time for holding, i.e., a small part takes less time than a large part. By careful manipulation a neutral and slightly reducing atmosphere can be maintained. Do not use too great excess air and keep the furnace doors closed as much as possible.

Gas Furnaces. Gas furnaces give excellent results for heat-treating. They are easy to adjust, and atmospheric conditions can be held either oxidizing or reducing which is a very important item. Every furnace should be cleaned out regularly. Oxide and other debris soon obstruct the flow of the heat and cause unequal heating; also in the case of gas, back-firing may result. In lighting a gas furnace open the door for a short time before tossing in a lighted piece of paper, then turn on the gas. Do not stand in front of the door when lighting.

Pyrometers. All heat-treating devices should be equipped with pyrometers. These must be checked regularly either by means of a standard pyrometer or constant melting-point materials. Care should be exercised in the method of placing the couple in the furnace or bath, for sometimes the heat registered is not the same as the heat at the point where the material is being heated. All couples should be inclosed in protecting tubes as they soon oxidize otherwise. The cold ends should be noticed to see that they are not unduly heated by the furnace. A good quick check on a pyrometer is to insert the couple in a molten bath of sodium chloride and plot the cooling curve.

LOW CARBON STEEL

Low carbon steel is used for tubing, sheet steel, carbonizing, nuts and bolts.

Tubing. There are two kinds of tubing used, seamless and welded. It has an average chemical analysis of 0.15 per cent carbon, 0.35 manganese, 0.045 sulphur, 0.014 phosphorus; and the following physical properties when quenched at 1625-1650 deg. in oil and drawn at 1000 degrees:

	Pounds per sq.in.
Ultimate strength.....	65,000
Yield point.....	59,500

Tubing is oxidized very much on being heat-treated but this can be reduced to a minimum by placing the tubing in containers (larger tubing) and excluding the air; then using speed in transferring to the quenching medium. The temperature for normalizing this steel is about 1650 degrees.

To determine whether the tubing is welded or seamless, a section about $1\frac{1}{2}$ inches long is ground smooth

on each end and placed in a 20 per cent solution of H_2SO_4 at a temperature of 150 deg. for 25 minutes. If welded it will show even without a microscope.

Defects often found in tubing are decarbonized spots or variations in carbon content from one end of a tube to the other, slag inclusions, seams, laps, etc. Fig. 12 shows a seam, the boundaries of which are decarbonized.

Sheet Steel has a composition of about 0.25 per cent carbon, 0.50 manganese, 0.045 phosphorus, 0.045 sulphur, and gives the following properties when quenched at 1600 deg. in oil and drawn at 1250 degrees:

Ultimate strength.....	70,500 lb. per sq.in.
Yield point.....	60,250 lb. per sq.in.
Elongation.....	30 per cent.

Raw stock drawn at 1000 degrees:

Ultimate strength.....	67,400 lb. per sq.in.
Yield point.....	59,700 lb. per sq.in.
Elongation.....	20 per cent.

The temperature for normalizing is 1575 to 1600 degrees.

Defects most often found are slag inclusions and laminated material. This laminated steel is caused from

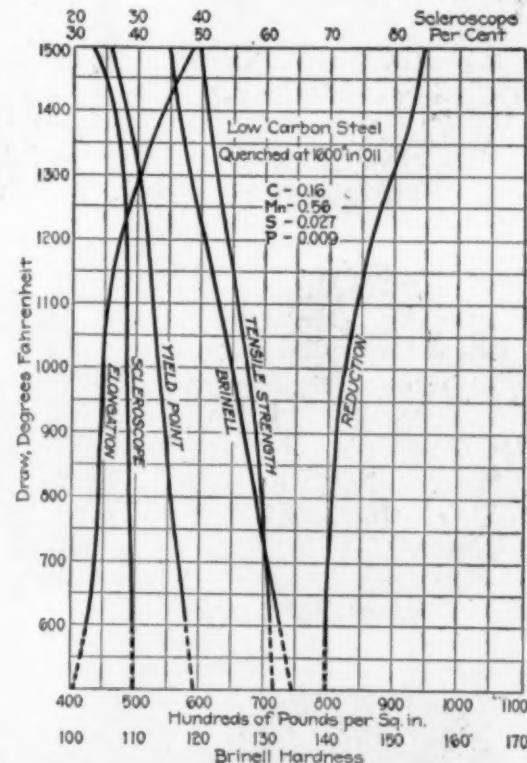
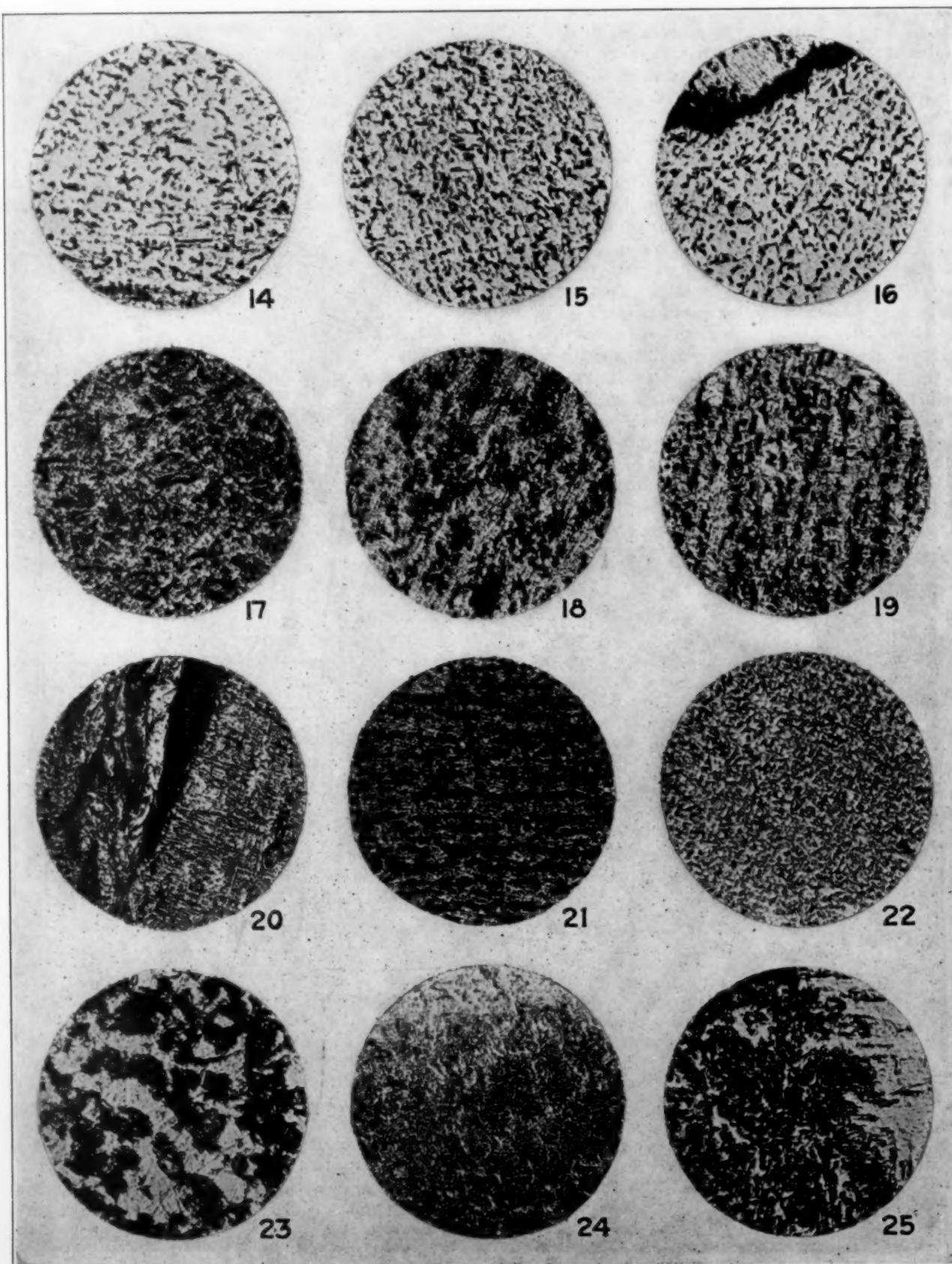


PLATE 1.—PROPERTIES OF LOW CARBON STEEL

cold rolling below the critical range, or sometimes by phosphorus which has expelled the carbon in slow cooling. It can be improved by long annealing at about 1650 deg. but hardly ever completely removed. Phosphorus occurs in solid solution in the ferrite. In crystallizing out, the phosphorus is maximum at the surface of each crystal. These crystals on being rolled form elongated masses or bands.

Tubing and sheet steel are made into many different parts. They should be annealed first or else there is danger of cracking and strains. After the material has been fabricated it is heat-treated by quenching in oil at about 1600-1625 deg. and drawing at from 900 deg. to 1100 deg., according to the strength wanted.



FIGS. 14-25

Fig. 14—Section of ear No. 1 at fracture; $\times 100$. Fig. 15—Same some distance from fracture; $\times 100$. Fig. 16—Section of ear No. 2 at fracture. The structure some distance away was same as Fig. 15. Fig. 17—Section from ear No. 3 at fracture; $\times 100$. Fig. 18—Same some distance from fracture; $\times 100$. Fig. 19—Section of ear No. 1 after annealing; $\times 100$. Fig. 20— $\times 100$. Fig. 21— $\times 100$. Fig. 22—General structure of the rim; $\times 100$. Fig. 23—The same; $\times 400$. Fig. 24—The weld; $\times 100$. Fig. 25—The same; $\times 400$.

In some cases normalizing is sufficient, that is, heating to 1575 deg. to 1625 deg. and then cooling in air.

In cleaning this material it is sometimes subjected to a pickling operation (immersing in dilute acid). Care should be exercised to prevent excessive action as the weakening effect is great. Much of this type stock is brazed or welded. Acids should not be used as flux and the steel should be in the annealed condition before the weld or braze is made. In heating, if the acetylene torch is used, a sufficient area should be heated to prevent cracks from expansion and contraction.

One case was found where aluminium had been used as a deoxidizer in the manufacture of the steel. It (Al_2O_3) had segregated in a line of dots and on brazing, being a line of weakness, caused the failure of the steel.

Carbonizing Steel has an average analysis of 0.20 per cent carbon, 0.50 manganese, 0.06 sulphur, 0.045 phosphorus. When quenched at 1625 deg. and drawn at 900 deg. it has the following properties:

Ultimate tensile strength.....	70,000 lb. per sq.in.
Yield point.....	51,000 lb. per sq.in.
Elongation.....	34 per cent.
Reduction.....	70 per cent.

In carbonizing, the part is left in the compound from six to twelve hours, according to the thickness of the case wanted, at a temperature of 1600 deg. to 1625 deg., then cooled in the boxes to room temperature.

This material is now quenched in oil from a temperature of 1600 deg. to 1625 deg., which gives a good tough core. A second quench is given at 1450 deg. to 1475 deg. in water, after which it is drawn at about 450 deg. to relieve any existing strains.

One lot of steel used for cam shafts because of open structure became brittle and showed tiny cracks after carbonizing. In order to get away from this condition the steel was first heat-treated and then carbonized.

It is not good practice to quench material direct from the boxes in water as the resulting structure is very coarse and brittle.

In Nuts, Bolts and Screws the phosphorus and sulphur sometimes run high, 0.10 per cent, in which case the nuts are brittle; also they show laminations. Nuts from this material can be improved by drawing at from 1000 deg. to 1150 deg. It is not advisable to use a high-sulphur high-phosphorus material, especially where they are under stress, as they are likely to fail suddenly, due to segregation of crystals. Of course, it makes a nut or a bolt that is very easy to machine and it will oft-times pass the physical tests without a special treatment, but it absolutely should not be used in this kind of work. The usual physical test is to compress the nuts 20 per cent of the shortest diameter of the nut.

All investigations indicate that low carbon steel causes more trouble than all of the other steels. Welded tubing is sometimes mixed with unwelded necessitating the sawing off of sections and treating them in dilute acid as spoken of before. Strain lines are set up by bending tubing without proper annealing and in the case of soldering, welding, and brazing, there are numerous illustrations of the tubing being burned. Too much emphasis can not be placed on the importance of properly neutralizing any remaining solution or salt used as a flux or cleaner. A soda wash after the

operation is very good for this. It is best to use a neutral flux such as borax, if possible. Brazed joints for tubing are superior to any other when properly heat treated as shown by conclusive data in chapter on brazing and welding. It is not necessary to heat any tubing to anywhere near a burning temperature to get perfect brazes.

The use of silver solder is not necessary unless on joints between copper and brass fittings. Ordinary brazing material has been used here successfully. Two important points in regard to silver solder are its great cost and its sluggishness in use.

Sheet steel and tubing should not be sand blasted before brazing as extra heat is necessary to get the brazing material to flow. This extra heat causes rejections from burning and splitting.

Quantities of laminated sheet steel are spoiled by sending to the punch presses to be fabricated into parts before being properly annealed or normalized.

There is always considerable scale formed in heat-treating steel. This is very objectionable as it necessitates the steel being carefully cleaned; also there is considerable reduction in size.

By immersing the steel in a dilute solution of hydrochloric acid, about 6 to 10 per cent, and then treating, we get a good, clean, smooth, bright surface. This is very important as there is a large labor saving and the steel is more desirable in many ways.

Many test pieces tried out after immersing and heat treating showed the same strength as other pieces quenched or annealed at the same temperature but not subjected to acid. The decrease in diameter of the part was very slight. In the case of bar stock it was about 0.0006 inch and the surface remaining was perfectly bright. This practice is certainly worth trying especially in annealing or quenching sheet-steel where the oxide formed without the immersing in the acid solution is very objectionable.

STEEL TUBING INVESTIGATION

This material on being inspected showed a peculiar streak about one-half inch wide extending the entire length of the tube. A section was taken from the streak, polished, etched with picric acid and photographed at a magnification of 100.

Fig. 13 shows that the streak along the tube was a decarbonized area probably caused by the tube coming in contact with some oxidizing agent (flame). This causes a line of weakness, necessitating rejection.

AEROPLANE FITTING INVESTIGATION

Three metal ears from certain aeroplane fittings, being fractured, are investigated to discover the source of the fracture. They were made from ordinary sheet steel. Sections from each of the ears were taken near the fracture and at the opposite side; also ear No. 1 was given a long anneal at 1650 deg. and then a section was taken. These sections were polished, etched with picric acid and photographed at a magnification of 100. The results are shown in Figs. 14 to 19 inclusive.

Summary. Ears 1 and 2 have a very laminated structure. The crystals were distorted by cold-working resulting in decreased ductility and increased brittleness. Strain lines would certainly be set up in bending such material, which would become enlarged by vibra-

tion. Ear 3 has a much better or softer structure than 1 and 2. It should bend easily and without the strain lines. Near the point of fracture it appears to have been bent several times before failing.

Ear No. 1, after annealing, showed as Fig. 19. This indicates that the material showing laminations as ear 1 and 2 should be given heat treatment before placing in the machine. Would suggest annealing at 1625 deg. first and then after the part is made a heat treatment of 1625 deg.; quench in oil and draw at about 100 deg. Fahrenheit.

INVESTIGATION OF TERNE PLATE

Terne plate showing raised spots or bubbles was investigated to see if the places were in the steel or between the steel and plating. Sections were taken, polished, etched with picric acid and photographed at a magnification of 100. Fig. 20 shows that the bubble or gas cavity was in the steel itself. There have been instances where the bubbles were under the plating and not in the steel.

STIRRUP INVESTIGATIONS

This stirrup (212100) showed lines on the side. These were investigated in order to determine their depth and to see if the material was distorted by any strain. Sections were taken from the place showing the lines. The sections were polished and examined and then etched with picric acid and photographed at a magnification of 100.

Summary. The scratches proved to be surface (die pinching) defects and had practically no depth. As shown in Fig. 21, the material is badly laminated due to rolling or excessive phosphorus. The scratches investigated are insignificant and if they are in the other parts as the one submitted will cause no damage.

The object of another stirrup investigation was to investigate the strength of the materials. The stirrups showed marks on the side that looked like cracks or strains. A part showing the marks was sectioned in two places, one showing the marks (this was heated to about 1300 deg. and straightened), and one some distance away without marks. These parts were pulled on the machines and showed as follows:

Sections heated and straightened:

A—71,500 lb. per square inch
B—72,000 lb. per square inch

Section as the material was:

A—70,500 lb. per square inch
B—68,500 lb. per square inch

Summary. This report checks out the photomicrographs in that the strength of the material is all right and the marks are surface marks only.

WHEEL RIM WELD

Wheel Rim Investigation. The object of this investigation was to contrast the structure of the steel at the weld and other places in the rim. Sections were taken, polished, etched with HNO_3 solution (10 cc. in 90 cc. C_2H_5OH) and then photographed. The results are shown in Figs. 22 to 25 inclusive.

Summary. The steel near the weld has its carbon content increased, probably due to the fact that a reducing flame was used in the process of welding. By a reducing flame is meant a flame with excess CO. There

should be sufficient oxygen to cause the complete reaction $2CO + O_2 \rightarrow 2CO_2$. A yellow flame indicates a reducing condition; but care should be taken not to confound this flame with a yellow flame caused by any soda in the air ($Na_2B_4O_7$).

(To be Continued)

Ownership of Chemical Concerns Probed by Alien Property Custodian

On the contention that the transfers of stock made just prior to the entrance of the United States into the war were not *bona fide*, the Alien Property Custodian has undertaken a searching inquiry into the ownership of Roessler & Hasslacher Chemical Co., New York; Niagara Electro-Chemical Co., Niagara Falls; and Perth Amboy Chemical Co., Perth Amboy, N. J.

According to the testimony of Wm. A. Hamann, treasurer of Roessler & Hasslacher, the stock in the three concerns was sold by Germans to American interests just before the entrance of the United States into the war because of a threatened power shortage at Niagara Falls and because of new processes being developed in this country which would be dangerously competitive.

Joseph H. Choate, conducting the inquiry for the Alien Property Custodian, questioned the good faith of the transfer and introduced a cablegram from Dr. Roessler stating that a decision could not be reached "without knowing your real intention and whether real business or formality only is meant." The cablegram also suggested sending a "confidential man" to Germany to negotiate for the transfer of the stock, which was done last January.

The close relationship of the three firms with a group of German industrialists was shown by the testimony of Franz Roessler, vice-president of the Roessler & Hasslacher Company. His father, Friedrich Roessler was the founder of the Gold and Silver Scheide-Anstalt at Frankfort which, until the alleged transfer of stock, owned the major interest in the Roessler & Hasslacher Chemical Co., the Niagara Electro-Chemical Co., and the Perth Amboy Chemical Co. In examining Franz Roessler, it was brought out by Mr. Choate that the relationship between the owners of the German and American organizations was so intimate that the transfer of stock worth millions was made without the formality of signing papers or transferring funds.

Mr. Roessler stated that the transfer was made on the basis of \$200 a share for Roessler & Hasslacher, \$400 for Niagara Electro-Chemical, and \$200 for Perth Amboy Chemical stock. Counsel for the Alien Property Custodian pointed out that this was a low figure, considering that the Niagara Company had paid dividends as high as 1100 per cent and the other two companies as high as 100 per cent each. To this Mr. Roessler replied that the pending break between Germany and America made the German owners anxious to dispose of their stock on the best terms they could get.

The quantity of limestone sold in the Bowling Green district, Warren County, Ky., in 1917, for use in building operations, according to reported sales of four companies, decreased by 55,126 cubic feet, valued at \$12,421 from that of 1916.

Flotation Apparatus, Their Design and Operation—II

Description of Machine Types, With Comparison of Their Operation, Metallurgical and Mechanical Differences, Capacity, Air and Power Consumption—Cost per Ton of Capacity

BY A. W. FAHRENWALD

THE previous article in this series undertook a discussion of several types of straight mechanical frothing machines, mechanical air frothing machines, and two types of pneumatic frothing machines, namely, the Callow and the Flinn-Towne machines. It was pointed out in the case of the latter that, although it embodied many desirable principles of construction, yet it has its limitations.

3. The Cole-Bergman Machine. This machine was designed to overcome several weak points in the above-described machine, namely, the porous medium through which the air is injected into the pulp, and the low capacity. For the carborundum disc was substituted a system of perforated tubes covered with a suitable

from the first cell pass down through the porous grate bottom into the chamber *C* where there is no agitation due to the injection of air into the pulp. From here the tailings are carried into cell No. 2 through an S-shaped pipe *N*. The discharge end *D* of this pipe controls the height of pulp-level in the first cell. The tailings finally leave the machine through the goose-neck discharge pipe *E*, while sand that is too coarse to be carried from cell to cell is drawn off through the spigot valve *S*. The froth formed in each cell overflows on four sides into a common launder. This gives the froth a minimum distance to travel in leaving the machine.

Lacking published data it cannot be said whether this tubular grate bottom is a success or not. I am

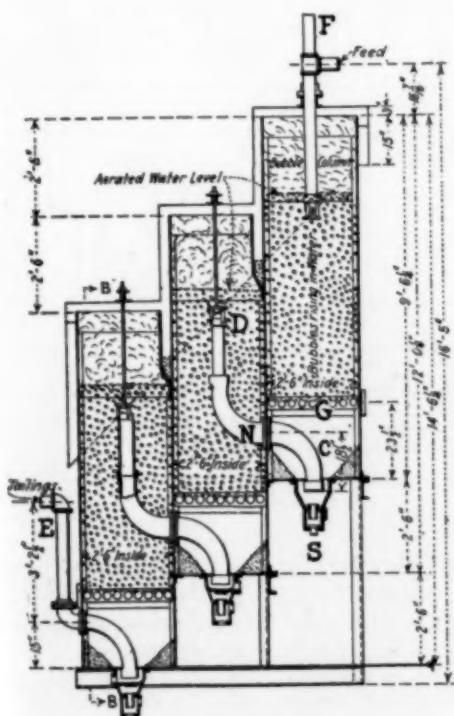


FIG. 9a

COLE-BERGMAN FLOTATION MACHINE

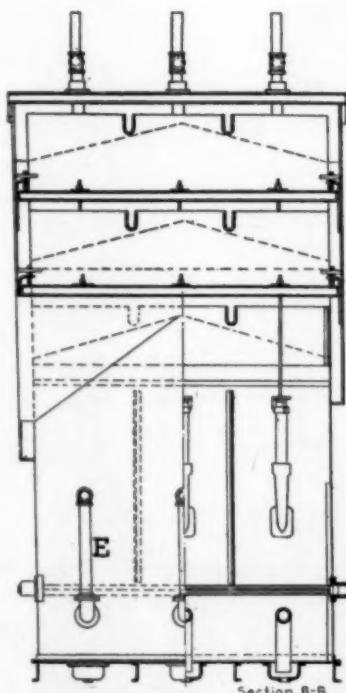


FIG. 9b

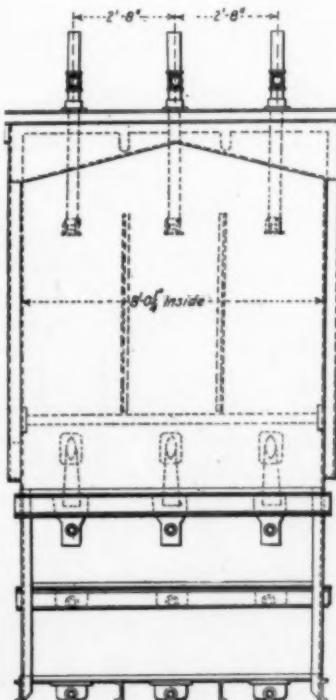


FIG. 9c

fabric, such as canvas or flannel. This led to the construction of a porous medium in the form of a grate *G*, as shown in Fig. 9a.

For the cylindrical cell of the Flinn-Towne machine was substituted rectangular ones 2 feet 6 inches wide by 8 feet 4 inch long and 9 feet 6 1/2 inches high; in this form they are placed side by side, making a very compact arrangement.

The feed enters the machine through three pipes *F* near the top and center of the first cell. The tailings

inclined to believe that it is somewhat complicated and that the ordinary bottom as used in the Callow Inspiration machine could be conveniently suspended in this sort of cell. The main fault with the carborundum bottom was in the clogging of the pores through which the air is forced.

4. The Inspiration Machine. In construction this machine is extremely simple, while in principle it shows one difference from the Callow machine, viz., that instead of splitting the pulp between a great number of

cells it is forced to travel through a series of compartments in succession. This same policy has been followed in the construction of the Minerals Separation machine.

Fig. 4 shows an Inspiration flotation machine of steel construction. The machine is divided into two compartments, A and B, each 24 feet by 8 feet 6 inches. Each compartment in turn is subdivided into eight sections, each 3 feet long. Between the compartments A and B is placed an overflow gate G which regulates the height of pulp in the minor sections of A, while the end

pan with longitudinal riffles, which riffles are cored as shown in section E-E for the interchange of air between the narrow channels thus formed. A steel spider G, Fig. 11, which forms the upper part of the porous bottom, is fastened to the lower part G' by a number of bolts around the edges. Before putting them together a porous medium (canvas) is placed between the two pieces. The air enters through a pipe P from the top which screws into the lower casting; arrangements are made, of course, to secure an air-tight joint J where the air passes through the porous medium.

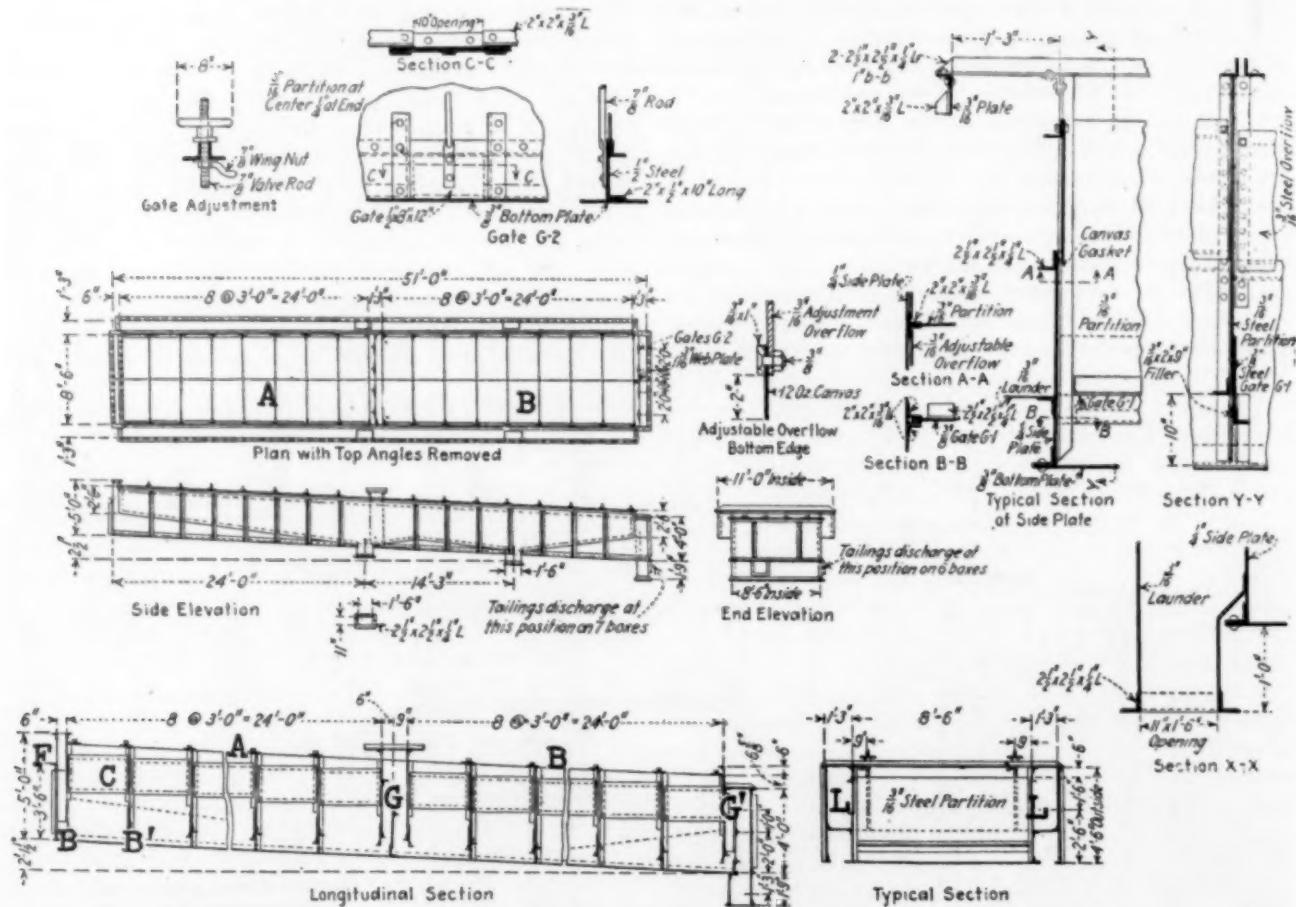


FIG. 10—INSPIRATION FLOTATION ROUGHER CELL.

of the second compartments is another overflow gate G' which controls the pulp-level in the sections of compartment B.

The feed enters the machine at F, passes under a baffle B and into the first section or cell C, where a froth is formed which overflows into the launders L on either side of the machine and running the entire length. The tails from this first section pass under the baffle B into the second section or cell where further froth is formed, continuing in this way through the entire length of the machine. The subdivision into two compartments is in the interest of closer regulation of the pulp-level.

In the Inspiration machine the bottom plates are all solid; all pipe connections are made from above and are at all times visible. The porous bottoms rest on top of the regular bottom of the machine and air is introduced from the top. Their construction is illustrated in Fig. 11, and consists of a shallow cast-iron

When assembled, the bars of the upper grate form channels in the lengthwise direction of the machine. These bars are the only part that protrude above the canvas, and, on account of their longitudinal arrangement, do not interfere with the passage of pulp through the machine.

5. The Launder Machine. This apparatus¹⁰ is similar to the Callow cell, making use of air under pressure forced through canvas or some other porous medium. In this machine the air distributor is loose and is lowered from the top of the cell. With this arrangement it is evident that a distributor can be removed for repairs without interrupting the operation of the machine.

It will be seen from Fig. 12 that the machine is quite simple in construction, being merely a vat divided into six sections, the pulp flowing through a by-pass B from one cell to the other. A drop of 3 inches from

¹⁰B. M. Snider, Min. & Sci. Pr. Aug. 11, 1917.

one cell to the other is sufficient to keep the pulp moving freely, and the flat bottoms of the cell permit an even air pressure and distribution in each cell.

The cells are 15 inches wide, and in effect the operation of the machine is the same as if the pulp were running through an aerated launder 15 inches wide and 30 feet long. The narrow width of the cells with the launders *L* on either side permits the froth to overflow with a maximum horizontal travel of less than 8 inches. The concentrate froth is broken up by a jet of water.

Mr. Snyder gives the total cost of this machine erected as \$450, not including blower. Five-pound pressure is required as a depth of 24 inches of pulp is maintained, and the air consumption is about 10 cubic feet per

square foot of frothing area. It has a capacity of from 250 to 300 pounds of mineral per square foot of frothing area.

IV. GRAVITY FROTHING MACHINES

This class of flotation machine has been given considerable attention of late, but in general it is

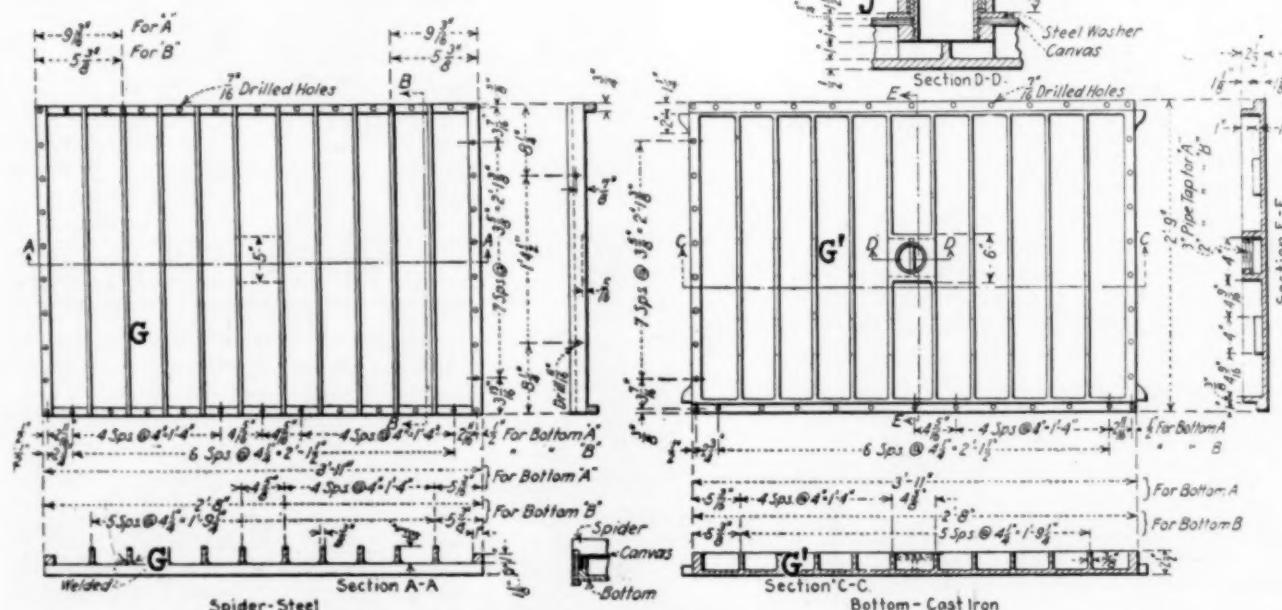


FIG. 11—INSPIRATION FLOTATION MACHINE BOTTOMS

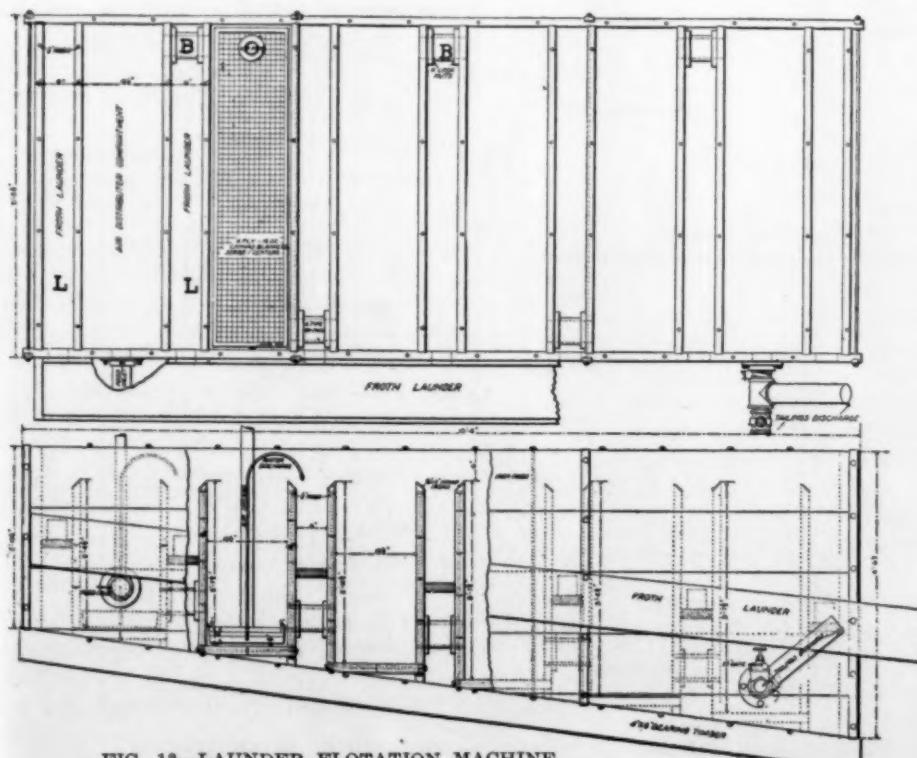
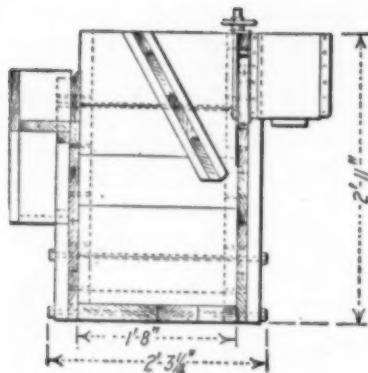


FIG. 12—LAUNDER FLOTATION MACHINE

doubtful if they can be of general success on account of the lack of agitation sufficiently violent to form a froth capable of performing its duties. In the *Engineering and Mining Journal* of May 19, 1917, an article on the "Cascade Flotation Machine" by C. R. Wilfley, and one April 14, 1917, on "A Hydraulic Flotation Machine," are of interest in this connection. A flotation machine of the "cascade" type was built and used a short time by the Ray Consolidated Copper Co.¹² to handle tailings from the other flotation machines. The machine was removed after a test that showed it to be inefficient. Fig. 13 shows a cascade machine¹³ installed and tried at

¹²D. H. Fairchild, *Eng. & Min. Journal*, Sept., 1917.

¹³Eng. & Min. Jour., Sept. 1, 1917.



the Central Mine, Broken Hill, Australia.

COMPARISON OF THE OPERATION OF THE DIFFERENT CLASSES

The object and purpose of all flotation machines in practice is to form a froth of mineral collector which, of course, is composed of air bubbles. Each bubble is loaded with mineral particles which it has picked up during its passage up through the pulp. These bubbles accumulate on the surface and are skimmed off or allowed to overflow by gravity.

In Class I, the pulp of proper consistency together with the proper amount of frothing agent passes into an agitating chamber where it is thoroughly emulsified and aerated. From this compartment it flows through an opening into a spitzkasten or settling compartment where the bubbles which have been beaten into the pulp collect mineral particles, drag them to the top to a tough and persistent froth which is skimmed off, broken up by some means, dewatered and dried as far as possible.

In Class II, 1 and 2, the pulp in an agitating compartment receives less violent mechanical agitation than in Class I. The aeration is aided by the injection of air into the pulp, thus relieving the impeller of part of its duty. Class II, 2, has a porous medium at the bottom of the settling compartment through which air is forced. This aids the bubbles formed by mechanical agitation to carry their load of mineral particles to the surface, where they are skimmed off.

In Class III the ore, water, oil and other reagents in an emulsified condition are subjected to the action of a bubble column. Air is forced through a porous medium of some kind, located at the bottom of the cell, circular or rectangular, but generally of the latter form. These bubbles are very small and proceed to pass up through the

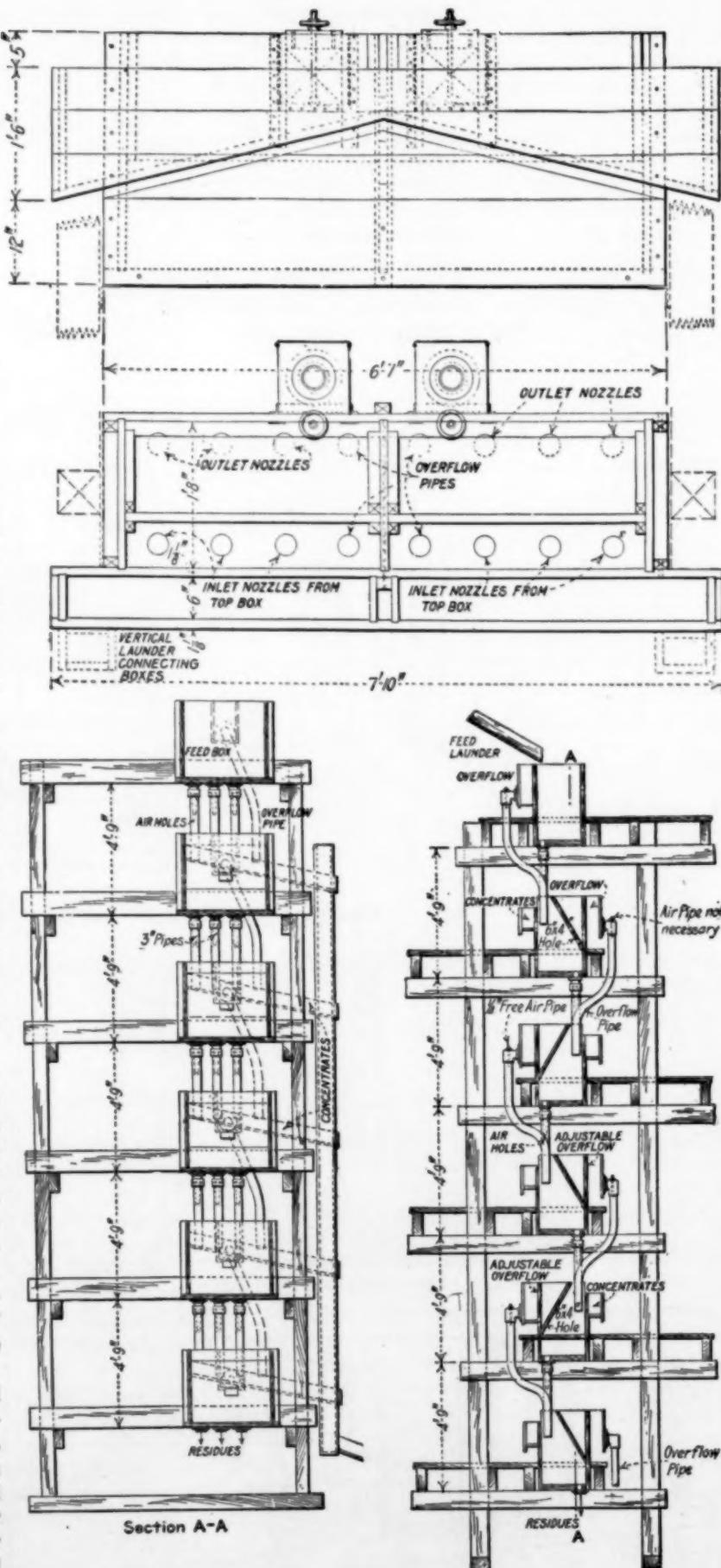


FIG. 12. A CASCADE MACHINE TRIED IN AUSTRALIA

pulp one after the other. During the early part of their trip they are coated with an exceedingly thin film of oil. In this condition they are capable of collecting mineral particles (generally sulphides), which are also oiled, carrying them to the surface forming a concentrate froth.

In comparing the machines of each class it will be seen that the only real difference in mechanical frothing machines is mechanical; the underlying principle is the same. The main point of difference between the Minerals Separation machine and the Janney is in the method of driving the impeller, the latter having an individual-motor-driven impeller. Other small differences, of course, exist in mechanical details of the two machines.

Turning to the pneumatic class of flotation machine, the Callow machine differs from others in two main respects, viz., in its pulp-level control device and in its sloping bottom. A uniform pulp-level in the Callow cell is maintained by a float and plug-valve, while in nearly all other machines of this class the constant pulp-level is maintained by an overflow gate or goose neck. The sloping bottom of the Callow cell calls for some means of giving a uniform discharge of air throughout the length of the cell under a varying hydraulic head. This is accomplished by dividing the porous medium into a number of sections each having an individual valve. Other pneumatic machines have a nearly level bottom over which the hydraulic head is constant. The Callow cells also are long and quite narrow, and the feed is split to several of them, while others, excepting the launder machine, are short and wide (taking the length in the direction of the flow of the pulp).

There is a tendency in machines of late design to lower the porous bottoms from the top of the cells, and to make all adjustments in their operation from above. This is the logical place to make the adjustments since any irregularity in the operation of the machine can be noticed while the adjustment is being made. Also any cell in the series can generally be cut out without hindering the operation of the remaining ones, excepting that they are momentarily overloaded.

FROTHS FORMED BY MECHANICAL AND PNEUMATIC MACHINES

One thing is sure—air bubbles produce the froths in both mechanical and pneumatic systems and often the same quantities of oil are used in pulps made up with the same quantities of water. Yet the pneumatic froth dies as soon as the supply of air is cut off, while the mechanical froth does not break down for a considerable length of time—occasionally weeks. When the machines are running the froths appear very much alike, except that the froth on the pneumatic machines appears whiter and does not seem to contain as much mineral.

As far as can be learned the difference between the two froths lies largely in the different percentages of air and moisture as compared with the amount of solids. The continual supply of air by the pneumatic method produces a condition under which each rising bubble carries only a few grains of mineral, whereas in the mechanical methods the bubbles come up fairly heavily laden.

The agitation in the pneumatic method, due to the

uprising and bursting bubbles, does not afford the ideal condition to form a froth of strength. The relatively quiet spitzkasten of the mechanical machine allows the bubbles to become loaded to capacity, and this seems to toughen the froth. O. C. Ralston¹⁷ states that it may rightly be called a "mineral mud." If a pneumatic machine is allowed to run for some time with no removal of froth the layer of froth on the top finally becomes similarly loaded, although the continual rush of large volumes of air through this layer keeps it more or less fluffy and wetter than a mechanical froth.

In conclusion it may be stated that the only difference in the froths produced by the two classes of machines is in the amount of water and air present for a given weight of mineral supported.

METALLURGICAL AND ECONOMICAL DIFFERENCES OF MECHANICAL AND PNEUMATIC MACHINES

Regarding this question Mr. O. C. Ralston makes the following statements:¹⁸ The two methods of flotation give nearly the same metallurgical results. However, comparisons made in a number of competitive tests indicate that the mechanical machines give a somewhat better extraction on coarse particles of minerals, and that the pneumatic machines make a better separation on the finer slimes—provided the oil has been well mixed with the pulp. With the same pulp the pneumatic machines give a very slightly better total extraction than the mechanical machines.

In practice the machine that gives the highest total extraction is usually considered the best. This is especially true in copper mills. In zinc mills the highest possible grade of concentrate is of importance and should be considered. Pneumatic machines require slightly less power and less labor.

POROUS BOTTOMS

It will be recalled that in most flotation machines canvas is the medium through which air is forced in order to give the necessary fine division. In the Flinn-Towne cell carborundum is used and is said by some not to give satisfaction on account of the clogging of the pores. Canvas may also be used in this machine.

Some experiments¹⁹ with porous mediums have been made by the Inspiration engineers. Rubber sheets perforated with a multitude of needle holes have given good results; their life is quite limited, however. Sponge rubber has also been tried, but without lastingly good results. The advantage of rubber should be, in the first place, its smoothness. It would have less tendency than canvas to permit the formation of incrustations. Besides, an elastic medium should have the additional advantage of avoiding the danger of catching small sand particles in the pores of the medium.

Canvas, four ply, stitched every half inch, is considered the standard medium.

A normal capacity for a standard roughing cell of the Callow type is 50 tons per 24 hours, but varies according to the nature of the ore. At the Inspiration mill, where flotation is practiced as the prime process,

¹⁷ "Answers to Questions on the Flotation of Ores," by O. C. Ralston. *Technical Paper*, 149.

¹⁸Ibid.

¹⁹"Notes on Flotation," by J. M. Callow, *Bull. A. I. M.* El. Dec. 1915. *Eng. & Min. Jour.*, Dec. 4, 1915. *Mex. Min. Jour.*, Dec. 15, 1916. *Met. & Chem. Engrg.*, Sept. 1, 1915.

each 1000-ton section employs 24 roughing cells and 4 cleaners in series, an average of 33.3 tons per roughing cell is made. At other plants a capacity of from 35 to 65 tons per cell is made.

The Inspiration standard duplex machine consists of 16 double roughing compartments 3 feet by 3 feet 4 inches and a cleaner cell of 6 double compartments 3 feet by 3 feet, treats 800 tons per day, giving a tonnage of 1.62 tons per square foot per day for a total combined area of rougher and cleaner of 492 square feet. These machines, as others, are capable of carrying a 100 per cent overload for short periods of time without much loss in the tailings.

The Kollberg and Kraut flotation machine, as recorded at the Burro Mountain Concentrator, treats 75 tons of dry feed per day per cell. The manufacturers claim for it a capacity of from 80 to 150 tons per day.

The Cole-Bergman flotation machine is designed to handle large tonnages and, according to Mr. David Cole, will handle twice that of the Callow cell for the same floor space. The three-stage machine shown in Fig. 9 will handle up to 400 tons per day.

The Flinn-Towne Cell, on account of its cylindrical shape, is not adaptable where large capacities are required. The cell shown is designed to treat 40 tons per 24 hours.

A bank of Minerals Separation machines, containing 15 agitators each, 3 feet square, and 14 spitzkastens, handles about 400 tons of sand or 175 tons of slime per day.*

Janney mechanical machines installed in a row of from 5 to 15 cells will treat from 100 to 500 tons per row.

Janney mechanical-air cells installed in a series of one mixer and 5 flotation cells will treat 200 to 250 tons per day of 24 hours.

AIR AND POWER CONSUMPTION

The air consumption per square foot of the Inspiration machine is about 11.8 cubic feet per minute at a maximum pressure of 4½ pounds. The actual power consumed is 2.63 kilowatt-hour per ton of ore treated. Callow cells at the National Copper Company, using approximately 950 cubic feet of air at 4 pounds pressure, and treating 500 tons per day on 8 roughers and 2 cleaners, require 3.5 hp. per cell or 1.25 kilowatt-hour per ton.

A Minerals Separation mechanical agitation machine, with 15 agitator compartments 2 feet square and 14 spitzkastens, as installed at Anaconda, required 45 to 55 hp. under full load.

For each Janney cell about 150 cubic feet of air per minute at 4 to 5 pounds pressure is required.

The Janney mechanical cell has a 10-hp. motor installed over each, while 8 hp. is required to operate it.

The following table of power used by machines gives an interesting comparison:

Machine	Kilowatt-Hours per Ton of Solids
Janney (with air basket)	4 to 6
Minerals separation, mechanical	4 to 5
Minerals separation, subaeration	3.5
Pneumatic	3
K. & K. (claim in catalogue)	2

These are of illustrative value only.

*"Flotation Concentrator at Anaconda." Bull. A. I. M. E., Mar., 1916.

COST OF FLOTATION MACHINES

The cost of flotation machines is usually the smallest item in the cost of a plant, especially when compared with that of crushing machinery, filters, housing, etc.

The following summarized table of a number of installations has been reduced to unit figures and is of interest in comparing pneumatic and mechanical machines:

MECHANICAL FROTHING MACHINES

Capacity, Tons per Day	Cost per Ton of Daily Capacity
25	\$30 to \$50
50	25 to 45
100	20 to 40
250	15 to 35
1000	12 to 25

PNEUMATIC FROTHING MACHINES

25	25 to 40
50	12 to 20
200	8 to 12
1000	6 to 8
5000	4 to 6

The wide variation in these costs is due to differences in the machines used and the ores treated. The figures, however, serve to illustrate what can be expected.

Texas School of Mines,
El Paso, Texas

Skilled Enlisted Men to Be Returned to Industries by the War Department

In response to appeals from all over the country, the War Department has decided upon a policy which will permit the return to necessary industries of highly skilled men taken from such industries, under a system of furlough which will be automatic, and which will not in the future as in the past leave to the discretion of company and other subordinate commanders the question of whether such furloughs shall be granted. Thousands of applications for such furloughs are now being sent out of Washington by various branches of the War Department, in response to the appeals of manufacturers and other producers of war material whose draftsmen, mechanics and other employees, engaged in the past and now upon Government orders for war work, have been taken from them by operation of the draft.

The adoption of the new policy means that enlisted men are to be returned to industry only in cases where the drafted man's employer is willing to swear that the man is badly needed and that no one can take his place. The Government department for which the manufacturer or other employer is working will, upon application, send a blank form to the employer, which he must fill out, swear to before a notary, and have signed by a government inspector who is conversant with the facts. The signed application then goes to the Adjutant General's office, with request from the interested Government department that the man wanted be granted an indefinite furlough, without pay, with the promise that after the need for the man's service has passed he will be returned to the Army and the Government notified.

While such men are on furlough they are not to be allowed to wear the uniform. The company employing such men must furnish the Government each month a report that such men are still in employment and the class of work engaged in. In case such men leave their employment, the employers must immediately notify the Government.

Aluminium and Its Light Alloys

Light Alloys of Aluminium Just Developing as Important Materials of Construction, Especially in Motor and Aircraft Industries—Discussion of Chemical and Physical Properties of the Element

BY PAUL D. MERICA*

PROBABLY no metal has experienced the rapid development of its manufacture and scope of application that aluminium has within the past 30 years. A curiosity 60 years ago, it has become almost a household and industrial necessity today, and the growth of its use and application has not yet ceased. The motor and particularly the aircraft industries, today, are demanding materials for construction that are strong and light. If the development of the use of the metal, aluminium, lies mainly in the past, that of the development of its light alloys is really just beginning, and the future conceals, without a doubt, most important discoveries concerning the properties and uses of these alloys.

During the past few years the metal and its alloys have been the subject of much investigation and study, the results of which are scattered throughout the technical literature at least of six languages and eight countries. The author has considered that a brief, comprehensive resumé of what is known about this extraordinary metal may be of value to the multitude of those who are today manufacturing, selling, buying or using it in any of its many forms, and who otherwise may not have access to the information relative to the characteristics of the metal.

The data and information have been put in the form of tables and curves; the curves have been reproduced in such dimensions that accurate interpolation of values on them is possible by the use of a rule graduated in decimal parts of a centimeter. The probable degree of accuracy of data is indicated, or implied, by the number of significant figures in the values given.

I. COMMERCIAL ALUMINIUM.

The metal, aluminium, is produced by the electrolysis of a bath of molten bauxite and cryolite in carbon lined pots. Owing to the impurities in the materials used, the metal thus obtained is itself not pure but contains small and equal amounts of both iron and silicon.

There are two well recognized grades of ingot aluminium on the market:

Grade 1 containing 99 per cent or more aluminium.

Grade 2 containing 98 per cent to 99 per cent aluminium.

These are furnished in ingot form and in the form of slabs or billets for rolling.

The Aluminum Co. of America is the sole producer in this country of metallic aluminium; there are, however, a number of firms which manufacture the metal or its alloys.

The story of the uses and applications of aluminium

*Bureau of Standards; a more comprehensive treatment of this subject will be given in a forthcoming circular of the Bureau of Standards. Numbers in parenthesis following authors' names refer to a bibliography which will be published at the end of this series of articles.

is a quite long one. As might be expected it has made a place for itself everywhere where lightness, malleability, high electrical conductivity, and moderate resistance to corrosion are service features.

About one-third of the production is consumed in the automobile industry (Richards, 39), where it is used in the form of castings and sheet for chassis and panelling. Other major uses of this metal are for cooking utensils and vessels of all kinds, for electrical conductor to replace copper and in the form of alloy castings. It is also used as a deoxidizing agent in the manufacture of iron and steel, in the Goldschmidt Thermite process, as a substitute for stone in lithographic work, as wrapping foil, as paint powder, as a constituent of the explosive ammonal, as the anode in electrolytic rectification cells; it is manufactured in every commercial form; bars, tubes, sheets, powder, foil, sections, and ingots. Richards (45) lists about 200 commercial and technical uses of aluminium.

It may be worth while to point out that aluminium may be used as a substitute in many cases for metals which are either more expensive or are difficult or impossible to obtain. During the present shortage of tin aluminium foil can be used to replace tin and tin-lead alloy foil; it can be used at least for many cases as a constituent of bronze castings to replace tin. The greater cost per pound of aluminium than metals such as lead and zinc should not be allowed to give a false impression of its cost. In many cases, such as that of foil, of small manufactured articles, and of many castings, the size and shape of the article is determined by its use, so that it is the cost per unit of volume of the material, not that per unit of weight which must be considered. Aluminium compares quite favorably in this respect with other metals as the following table indicates.

Metal	Cost per Unit of Weight, per Lb.	Cost per Unit of Volume, per Cu.In.
Copper.....	15c.	4.8c.
Tin.....	38c.	10.0c.
Lead.....	4c.	1.6c.
Zinc.....	5½c.	1.4c.
Aluminium.....	23c.	2.2c.

II. METALLOGRAPHY OF ALUMINIUM.

Aluminium undergoes no thermal or other transformation in the solid state. Its microstructure is quite simple; the metal consists of grains or crystals within which are formed "rests" of the iron-aluminium compound, $FeAl_3$, and of silicon. The microstructure is shown in figures 1 to 4. These impurities undoubtedly have a considerable effect on the properties of the metal and even on those of its light alloys.

III. CHEMICAL PROPERTIES.

Aluminium is a very active element and under proper conditions reacts readily with other elements and substances such as chlorine, sulphur, oxygen. Its molecu-

lar heat of combustion is ($\text{Al}_2\text{O}_3 = 102.2$ grams) 392,600 calories.

The ease, however, with which aluminium reacts with oxygen, water, etc., is very dependent upon the physical state of the metal. As a powder or in an amalgam for example it reacts quite readily with air, water and other substances as one would expect from its high heat of reaction. As a solid mass, however, its rate of reaction with the same substances is very much slower, often almost unnoticeable; this in many cases, as for example its behavior towards oxidation, is undoubtedly due to its protection by a thin coating of reaction product, be it oxide, hydrate or otherwise. An important corollary of this fact is that the rate of corrosion of aluminium and of its light alloys depends on whether this protective coating of oxide once formed remains in place, protecting the remainder of the metal, or whether it is removed as it is formed. Thus the corrosion of the metal and its alloys is much more rapid in running water, and under conditions in which air and water erosion also play a part than in still water.

Aluminium in the solid form is corroded slowly and superficially only by pure water. In the air, damp or dry, it is also only superficially oxidized. When heated to 400°C . for 10 minutes in air a beginning oxidation is noticed which increases slowly up to 800°C . and then increases rapidly. Very finely divided aluminium, wire or foil, will decompose water very slowly but noticeably at 100°C .

Ammonium hydroxide attacks aluminium slowly, forming aluminium hydrate; sodium and potassium hydroxides (NaOH and KOH) attack it quite rapidly.

Sulphur, free or dissolved in carbon disulphide (CS_2) does not affect aluminium at ordinary temperatures.

A solution of mercury salt attacks aluminium, the mercury liberated by the reduction of the salt amalgamates the aluminium. The aluminium in this amalgam is very active and from it aluminium oxide is very rapidly formed by the action of water. Aluminium articles must therefore be protected from the action of mercury salts.

Cold concentrated or dilute nitric acid (HNO_3) attacks aluminium only very slowly; the metal becomes "passive" under the action of this acid. Dilute and concentrated sulphuric acid (H_2SO_4) attack aluminium but slowly when cold. When concentrated sulphuric acid is heated with aluminium the latter is attacked with formation of sulphur dioxide (SO_2). Dilute and concentrated hydrochloric acid (HCl) readily dissolve aluminium, as well as other mineral acids in the presence of metal chlorides.

Seligman and Williams (99, 100, 102) have carried out extensive tests of the resistance of aluminium to corrosion by acids, particularly nitric, sulphuric and acetic acids, the results of which are of the greatest practical value in view of the extensive use of aluminium for kitchen utensils and for acid vats and condensers. Their conclusions follow:

The rate of attack of aluminium by cold acetic acid is small; it increases with increasing dilution of the acid. Aluminium vessels can be used for containing concentrated nitric acid, when cold; with hot nitric acid of any concentration aluminium has but a limited life. Dilute, cold nitric acid also can be handled in aluminium vessels,

but the life of the latter is not as long as with the concentrated acid.

The corrosion of aluminium is greater in mixed sulphuric and nitric acids than in either alone (contrary to previously held opinion), and aluminium vessels should be used only with caution for handling such mixed acids.

The presence of impurities, iron, silicon and copper is of little influence on the corrosion in acids; the presence of copper is much more injurious when the corrosion is by dilute acids than when by concentrated acids.

1. CORROSION

Our detailed knowledge of the corrosion of aluminium is perhaps largely due to Heyn and Bauer (130) who in a very thorough investigation described the characteristic variations in the behavior of aluminium to corrosion in water or air and studied the effect of different conditions upon this corrosion. Their investigation was made following an extensive epidemic of disintegration of aluminium cooking utensils which were then being put on the market. Upon storing, many of these became exfoliated, cracked and blistered, undergoing in many cases an almost complete disintegration.

Heyn and Bauer found that aluminium undergoes two types of corrosion; it may corrode uniformly, a coating of oxide being formed over the whole surface, or it may be attacked locally, with formation of blisters and exfoliation. The latter type of corrosion is of course most dangerous and destructive; it appears to occur only when the aluminium is in the hard or cold worked condition and with certain types of tap water or salt solutions. Calcium salts seem to be accelerators of this type of corrosion. Tap water for example produces only slight uniform corrosion after several months on soft or annealed sheet; whereas it causes local corrosion, blistering and disintegration with hard sheet. Distilled water and many other salt solutions on the other hand will not cause blistering even with hard sheet. Heyn and Bauer suggest that cooking utensils might well be annealed in order to eliminate entirely the danger of local corrosion.

This distinctive type of local corrosion is probably due (1) to the presence of initial stresses in the hard sheet which cause strains and buckling when released by corrosion and (2) the fact that as Heyn has shown "hard" aluminium is electropositive to soft or annealed aluminium (by about 0.03 volts in tap water).

An idea of the extent of corrosion undergone by aluminium may be gained from the following tables taken from Heyn and Bauer's results:

In distilled water, with access of air, the diminution in thickness of the sheets (from 0.8 to 1.2 mm. thick) in 207 days was:

for "hard" sheet.....	0.0045 mm.
for "medium" sheet.....	0.0048 mm.
for "soft" sheet.....	0.0054 mm.

Samples of "medium hard" sheets showed the following losses in weight after 61 days in sodium chloride (NaCl) solution of the following concentrations:

0.34/N	NaC	.0015 mm.
0.86/N	NaC	.0024 mm.
3.42/N	NaC	.0029 mm.

No effect of varying silicon content of the aluminium within the range 0.57 per cent to 0.86 per cent of silicon

was noticed upon the type or amount of corrosion. It is not attacked by water in the absence of air or oxygen.

The corrosion is much increased as the temperature rises. For example, a sample of medium hard sheet

The Aluminum Company of America (12) states that aluminium "withstands the action of sea water better than iron, steel or copper. Strips of aluminium placed upon the sides of a wooden vessel were found

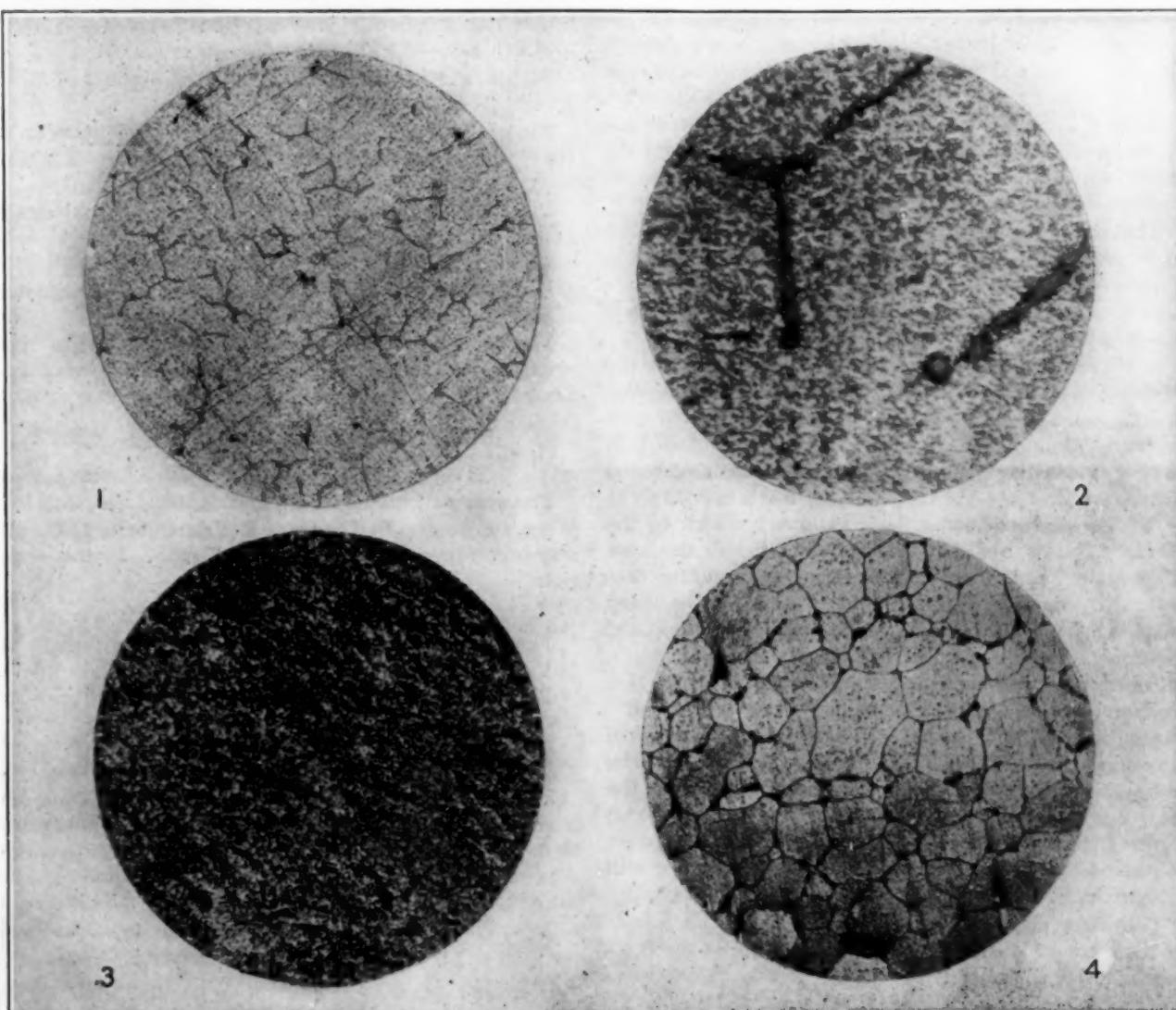


FIG. 1—NINETY-NINE PER CENT ALUMINIUM INGOT;
ETCHED WITH 0.10% NaOH; $\times 100$

FIG. 3—HARD-ROLLED ALUMINIUM SHEET (ANDERSON,
96); ETCHED WITH HF; $\times 100$

showed the following decrease in thickness after 48 days in tap water:

at 20° C.	.00039 mm.
at 70° C.	.0011 mm.

Bailey (121) finds that the presence of copper and sodium in it increases the corrosion of aluminium, and that in general the greater the purity of the metal the less the corrosion.

Guillet (123) finds that soda solutions attack aluminium and its alloys very rapidly. A sample of aluminium which lost only 2 mg. weight after 8 weeks in Seine water lost 3.95 grams after the same time in a 1 per cent soda solution. Alloys containing copper are much more readily attacked than pure aluminium and he corroborates Heyn's claim that in general cold worked or hard aluminium resists attack less than the soft or annealed metal.

FIG. 2—ALUMINIUM INGOT; ETCHED WITH 0.10% NaOH;
 $\times 1000$

FIG. 4—ANNEALED ALUMINIUM SHEET (ANDERSON, 96);
ETCHED WITH HF; $\times 50$

to be corroded less than .005 in. after 6 months exposure to sea water. Copper sheet treated similarly was corroded nearly twice as much."

2. PROTECTION OF ALUMINIUM AGAINST CORROSION

Both aluminium and its alloys are attacked by sea or salt water; the alloys of aluminium are attacked also by fresh water in which aluminium is much more stable. In order therefore to be able to utilize these alloys for construction purposes some method of protection against corrosion must be sought.

Of particular significance is the question of the protection of such alloys against corrosion in aircraft construction. Frames, beams and struts for rigid dirigible construction have already been made entirely from aluminium alloys and it is quite possible that similar construction will be tried for aeroplane construction to

replace parts now fabricated of wood, since there is now no doubt of the mechanical superiority of the alloy, duralumin, weight for weight, to wood or steel. An objection often raised against the use of these alloys is that they will corrode when exposed to the weather for any length of time.

Although it is impossible to electroplate aluminium, the effectiveness of such a coating is highly questionable. The coatings on aluminium do not adhere satisfactorily, and the metals used are all electronegative to the aluminium, such that if the coating were once punctured the corrosion at that point would be to a great degree accelerated.

The use of a paint, varnish or enamel seems the most promising solution of the problem. Some experiments carried out by Sabin in 1896 (135) will indicate how far the protection of aluminium by such means is possible today.

Sabin carried out two series of tests using in the first series 30 plates of aluminium and aluminium alloy and 25 plates in the second set. These were coated with various paints, enamels, and varnishes, suspended in cages: (1) in the first series, from 5 to 6 ft. below the water level in New York Navy Yard for 6 months; (2) in the second series, for 2 years in the water of the Norfolk Navy Yard, and about 13 months in the New York Navy Yard. The first series of tests showed that several coatings, namely, "Sabin process" pipe-coating enamel, baked; "Durable metal coating," both baked and unbaked; chromium oxide in Kauri resin oil-varnish, unbaked; Spar varnish, baked and unbaked; white zinc in Kauri resin oil-varnish, gave practically perfect protection to the 5 alloy series. In many cases blisters had formed in the coating, but no corrosion had set in. The same plates were again immersed in the water at the New York Navy Yard in 1897 for about 13 months; some of them were lost, but those which were not were recovered and upon examination were found to be still uncorroded.

The same may in general be said about the results of the second series of tests, although some of the coatings, notably those made with oil alone as a vehicle were destroyed by this exposure. Many remained absolutely intact, while during the same time heavy iron supporting chains were completely rusted away. The general conclusion from these tests is that aluminium and its alloys can be efficiently protected against corrosion under most severe conditions by the use of an enamel or varnish paint (the oil paints proved very inferior in these tests), and this fact, the result of extensive tests, is recommended to the attention of the aeronautical engineer for his investigation.

IV. PHYSICAL PROPERTIES

There are given below the best values available for the most common physical properties of commercial purest aluminium:

The density of annealed aluminium is 2.702; that of cold worked metal, 2.70.

The electrical resistivity is 2.828 microhm cm.; this corresponds to 60.3 per cent of the electrical conductivity of annealed copper (International Standard).

The temperature coefficient of electrical resistivity at 20 deg. is .0039.

The thermo-electromotive force of aluminium to copper (Northrup, 156) is given by the formula

$$10^{\circ} E = 4.51 t - 0.0122 t^2 + 0.0000433 t^3.$$

The electrolytic solution potential of aluminium to a normal solution of its normal salts with sulphuric, hydrochloric and nitric acids respectively is + 1.040, + 1.015 and + 0.775 volts (Neumann, 160).

The magnetic susceptibility of aluminium is + 0.65 $\times 10^{-6}$ (Honda, 161).

Aluminium melts at 658.7° (Bureau of Standards, 163), and boils, under atmospheric pressure, at about 1800°C. (Greenwood, 164).

The heat of fusion of aluminium is approximately 64 cal. per gram (Laschtschenko, 98).

The thermal conductivity of aluminium at 18° C is .504 cal. per 1 deg. C., per second, per cubic centimeter (Lees, 166).

The thermal expansivity of aluminium may be represented by the following equation (Bureau of Standards):

$$\frac{\Delta l}{l_0} \text{ (between } 0 \text{ deg. and } 300 \text{ deg. C.)} = (22.3 t + .011 t^2) \cdot 10^{-6}.$$

The specific heat of aluminium at 18°C. is .2143 cal. per gram, degree C. (Jaeger and Dieselhorst, 153). It may be represented between 0° and 100°C. by the equation

$$s = .2124 + .000104 t.$$

The total heat required to heat aluminium from 0°C. to its melting point is 187 cal. per gr. (Latschenko, 98).

The optical reflecting power of aluminum for $\lambda = .583 \mu$ is 83 per cent (Drude, 181).

V. MECHANICAL PROPERTIES.

Elasticity. The best values for E, the (Young's) modulus for elasticity are given by Brislee (183) for 99.3 per cent aluminium bars and wire. This mean value is

$$E = 9,810,000 \text{ lb./sq. in at } 17^{\circ}\text{C.}$$

$$\text{for bars, } E = 9,840,000 \text{ lb./sq. in.}$$

$$\text{for wire, } E = 9,790,000 \text{ lb./sq. in.}$$

Koch and Dannecker (182) gives the following values for the modulus (F) of torsion ($E = (\text{aprox.}) 2.72 F$) at higher temperatures:

Temperature, °C.	Modulus of Torsion, Lb. per 1 Sq.In.
20	3,870,000
100	3,730,000
200	3,450,000
300	3,100,000
400	2,630,000
450	2,030,000
500	680,000

Poisson's ratio (μ) is given by Cardani (185) as .363, by Schaefer as .359. A mean value of .36 may be accepted. (Katzenelsohn finds that μ increases 15.7% between 0° and 100°C.

Tensile Test. Aluminium may best be "normalized" by mechanical working (rolling, drawing, forging) followed by annealing at about 400°C. In this, soft state it possesses the following mean tensile properties:

Tensile strength 12,500 to 15,000 lb./sq. in
8.78 to 10.54 kg./sq. mm.

Yield point 8000 to 9000 lb./sq. in.
5.52 to 6.32 kg./sq. mm.

Elongation in 2 in..... 10—40%
Reduction of area..... 20—30%

The following table (No. 1) will give an idea of the tensile properties of this metal in other forms.

TABLE I—TENSILE PROPERTIES OF ALUMINIUM (1)

Form	Tensile Strength	Tensile Test Yield Point	Elongation in 2 In.	Reduction of Area
Sand cast.....	11,000-13,000	8,500	15-25	20-30
Chill cast.....	12,000-14,000	9,000	15-25	.....
Sheet:				
Annealed.....	12,000-15,000	8,000-9,000	12-35	20-30
Half-hard.....	18,000-22,000	9,000-12,000	5-12	20-30
Hard.....	22,000-35,000	12,000-25,000	1-7	20-30
12 gage.....	25,000	.....	7	.....
16 gage.....	28,000	.....	5	.....
20 gage.....	30,000	.....	3	.....
Bars (hard).....	28,000-35,000	14,000-23,000	.....	30-40
Wire (hard).....	25,000-55,000	16,000-33,00	.....	40-60
40 mil.....	31,000	.....	.....	.....
80 mil.....	28,000	.....	.....	.....
120 mil.....	25,000	.....	.....	.....
200 mil.....	22,000	.....	.....	.....

(1) These figures are by the Aluminum Co. of America (12), and others.

Gavey (196) has found that the duration of application of stress has a marked effect on the ultimate tensile stress. Hard drawn aluminium wires which had been in service as electrical conductors for a few months and had become somewhat corroded showed the following ultimate tensile stress:

Time of Application of Ultimate Breaking Load	Breaking Load, Lb.	Tensile Stress (1), Lb. Sq.In.
Ordinary tensile test.....	325	25,300
½ hour.....	300	23,300
3 hours.....	280	21,800
118 hours.....	240	18,700
525 hours.....	220	17,100
1,900 hours.....	Not broken but still stretching	.....

(1) Wire weighed 75 lb. per mile—was, therefore, apparently No. 10 British wire gage—values in column 3 calculated on this basis.

Compression test. The behavior of aluminium in compression is described by the Aluminum Co. of America (12) as follows:

Elastic limit (1)..... 6000-25,000 lb./sq. in.

Ultimate strength (1) 16,000-100,000 lb./sq.in.

Elmendorf (189) finds an average value (11 tests) of 67,000 lb./sq.in. for the ultimate strength of cast aluminium.

Hardness. The sclerometer hardness (magnifying hammer) of annealed or of cast aluminium varies from 4 to 6. The hardness of cold-rolled sheets is increased to from 13 to 15; the Brinell hardness (500 kg., 10 mm. ball, 30 seconds) of cast aluminium varies from 23 to 28.

Ductility (Erichsen test). The ductility of soft annealed aluminium sheets, such as are used for stamping and drawing is well indicated by the Erichsen test. Average Erichsen values (187, 188) are given below for different gages of commercial aluminium sheets:

B.&S. Gage	Thickness in In.	Erichsen Value
28	0.0126	5.5-7.5
26	0.0159	7.0-8.0
24	0.0201	7.0-8.0
22	0.0253	7.0-8.5
20	0.0319	7.5-9.0
18	0.0403	8.0-9.5
16	0.0508	9.0-10.5
14	0.0640	10.0-11.5
12	0.0808	10.5-12.0
10	0.1018	11.0-12.5

Alternating stress test. The only tests of which results are published are those on the White-Souther machine by Elmendorf (189), on cast aluminium of tensile strength averaging 15000 lb./sq. in. He finds the following relation:

$$S = 48,000 R^{-0.113}$$

S = fiber stress

R = No. of reversals to rupture.

This gives for 10,000 lb./sq.in. fiber stress, one million reversals, for 7800 lb./sq.in., ten million reversals.

MISCELLANEOUS

Density. Seven samples of hard drawn wire of from 99.52 to 99.60 per cent aluminium, tested at this Bureau

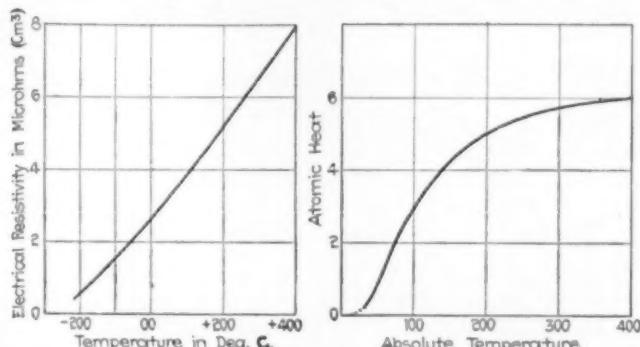


FIG. 5.—EFFECT OF TEMP. ON ELECTRICAL RESISTIVITY OF KAHLBRAUM ALUMINIUM (NICCOLAI, 205)

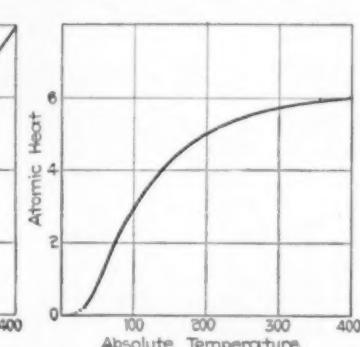


FIG. 6.—EFFECT OF TEMP. ON ATOMIC HEAT OF ALUMINIUM (NERNST)

TABLE II—EFFECT OF TEMPERATURE ON THE ELECTRICAL RESISTIVITY OF KAHLBRAUM ALUMINIUM (NICCOLAI, 205)

Temperature in °C.	Electrical Resistivity in Microhm-Cm.	Temperature in °C.	Electrical Resistivity in Microhm-Cm.
-189	0.641	+125	4.192
-175	0.795	+150	4.496
-150	1.038	+175	4.827
-125	1.282	+200	5.172
-100	1.535	+225	5.518
-75	1.782	+250	5.850
-50	2.067	+275	6.204
-25	2.321	+300	6.559
0	2.618	+325	6.917
+25	2.925	+350	7.274
+50	3.237	+375	7.638
+75	3.562	+400	7.991
+100	3.858		

TABLE III—TENSILE TESTS OF HARDDRAWN ALUMINIUM TUBES (BREUIL, 204)

(a) Effect of annealing. (1)

Temperature of Anneal in °C.	Tensile Strength, Lb. per Sq.In.	Yield Point, Lb. per Sq.In.	Elongation in 2.7 in. Cm. %	Reduction of Area, %
Hard	31,600	30,900	4.0	18
100	35,800	31,600	6.6	15
200	31,600	18,100	5.6	31
300	21,600	15,000	22.2	42

(1) Tubes were annealed in oil (time not given) and tested.

(b) Effect of temperature on properties.

Temperature of Anneal in °C.	Tensile Strength, Lb. per Sq.In.	Yield Point, Lb. per Sq.In.	Elongation in 2.7 in. Cm. %	Reduction of Area, %
20	31,600	30,800	4.0	18
100	29,900	29,900	9.6	24
200	20,800	15,800	22.2	41
300	10,100	10,100	31.4	35

TABLE IV—TENSILE TESTS OF ALUMINIUM BARS AT HIGHER TEMPERATURES (1) (BAUMANN 201)

Temperature, °C.	Tensile Strength, Lb. per Sq.In.	Elongation in 5.9 Cm. (1.97 in.)	Tensile Properties	
			Annealed	Not Annealed
20	14,000	43.3	64.5	43.7
60	12,600	49.9	71.9	56.8
100	9,860	66.8	76.6	66.0
200	5,980	78.1	87.2	76.9
300	3,360	79.8	92.8	83.7

(1) These tests were made on 99% aluminium bars 17, 12, 8 and 4 mm. thick. The values given are averages of the results for the bars of the 4 thicknesses.

TABLE V—EFFECT OF TEMPERATURE ON THE TENSILE PROPERTIES OF ALUMINIUM (BENGOUGH, 200).

Temperature of Test, °C.	Tensile Strength, Lb. per Sq.In.	Elongation in 2 In. %	Reduction of Area, %
20	19,200	12	75
200	14,100	15	78
275	11,110	17.2	79
330	7,600	20.3	88
375	3,800	25	88
396	2,150	56	90
450	.....	65	96
520	900	88.5	to finest
565	540	70.3	possible
610	660	75.0	point
625	420	39.0	92

averaged 2.6991 in density, ranging from 2.6983 to 2.6996 (151). Brislee (143, 144) has shown that the density of aluminium depends upon the heat treatment

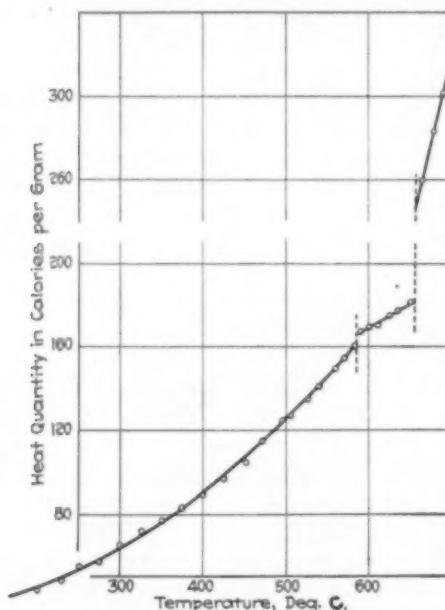


FIG. 7—TOTAL HEAT IN ALUMINIUM BETWEEN $t^{\circ}\text{C}$. AND 24°C . (LASCHTSCHENKO)

and amount of mechanical working it has suffered. He found that the mean increase of 7 samples of density of cold worked metal upon annealing was 0.0017 or 0.063 per cent. Annealed aluminium may be regarded as having a density of 2.702, cold worked or hard aluminium one of 2.700.

VI. PHYSICAL PROPERTIES AT HIGHER AND LOWER TEMPERATURES.

Niccolai (205) has determined the specific electrical resistivity of aluminium at temperatures from -180°C .

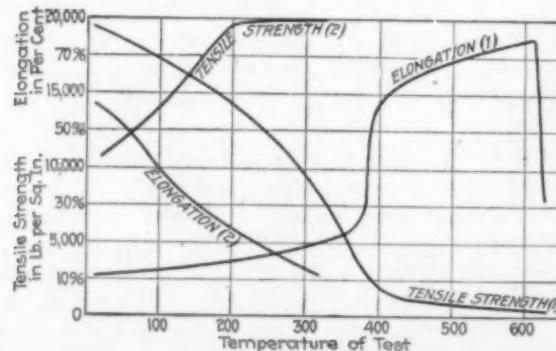


FIG. 8—EFFECT OF TEMPERATURE ON TENSILE PROPERTIES OF ALUMINIUM (BAUMANN) (BENGOUGH)

to 400°C . His values are given in Table 2 and plotted in Fig. 5. Lees (166) also gives similar values for the electrical resistivity at lower temperatures.

The effect of low temperatures upon the atomic heat of aluminium is shown in the Fig. 6 from data by Nernst (202).

The total heat of aluminium at higher temperatures has been measured by Laschtschenko (98) from t° to 24°C . His results are plotted in Fig. 7.

Lees (166) gives the following values for the thermal conductivity of 99 per cent aluminium.

Temperature in $^{\circ}\text{C}$.	Thermal Conductivity in Cal. per Sec.—per cm^2 —per 1°C .
-170	0.524
-160	0.514
-150	0.508
-125	0.491
-100	0.492
-75	0.493
-50	0.496
-25	0.499
0	0.502
+18	0.504

Investigation has been made by Breuil (204), Baumann (201), and Bengough (200), of the effect of temperature on the tensile properties of aluminium. Their results are shown in the Tables 3, 4 and 5, and in Fig. 8. The variation in the results is due in all probability to the difference in the speed of testing which has undoubtedly much effect on the results obtained.

(To be Continued)

Asphalt and Petroleum Residues in 1917

Statistics just completed under the supervision of J. D. Northrop of the U. S. Geological Survey show a marked decrease in the production of maltha, gilsonite, elaterite and grahamite, bituminous rock, and ozokerite—80,904 tons valued at \$735,924 being produced, which is 17,570 tons less than in 1916.

The quantity of manufactured asphalt (including road oils and flux) produced in 1917 from petroleum of domestic origin increased about 2 per cent compared with 1916, and the quantity of corresponding material manufactured in this country from Mexican petroleum increased about 13 per cent, as a consequence of which the net gain over the production in 1916 was nearly 7 per cent.

The total sales in 1917 of manufactured asphalt derived from domestic petroleum amounted to 701,809 short tons, valued at \$7,734,691. This total includes 327,142 tons, valued at \$4,011,980, of solid and semisolid products used in the paving and roofing industries, and 374,667 tons, valued at \$3,722,711, of liquid products, including road oils, flux, and asphaltic paints.

California maintained its supremacy in the production of oil asphalt. Its output from 14 petroleum refineries in 1917 aggregated 220,294 tons, valued at \$2,100,252, and included 135,160 tons of solid and semisolid products, valued at \$1,486,609, and 85,134 tons of liquid products, valued at \$613,643. Refiners handling oil from the Oklahoma-Kansas field produced 206,223 tons of oil asphalt, valued at \$1,975,493, including 73,410 tons of solid and semisolid products, valued at \$747,651, and 132,813 tons of liquid products, valued at \$1,227,842.

The total sales in 1917 of manufactured asphalt derived from Mexican petroleum amounted to 645,613 short tons, valued at \$7,441,813, and included 338,485 tons of solid and semisolid products, valued at \$4,657,152, and 307,128 tons of liquid products, valued at \$2,784,661.

The imports of native asphalt, oil asphalt, and bituminous rock for consumption in the United States in 1917 aggregated 187,886 short tons, valued at \$993,115, a gain in quantity of 40,173 tons, or 28 per cent, over 1916. The exports of unmanufactured asphalt in 1917 amounted to 30,107 short tons, valued at \$587,256, a loss of 10,709 tons, or 35 per cent, compared with 1916. In addition asphalt products to the value of \$585,472 were exported in 1917.

The Deresination of Rubber

A Resumé of the Art of Improving Low-Grade Rubber by Removal of Resin—Outline of Processes Proposed—Deresination of Guayule May be Resumed in a Short Time

BY ANDREW H. KING

In PREVIOUS papers the writer has pointed out that rubber may be represented by the chemical formula $2(C_{10}H_{16})_n$. The subscript n denotes the degree of polymerization on which depends, to a great extent, the value of the rubber, i.e., whether it is high- or low-grade. $C_{10}H_{16}$ is the basic formula for the whole terpene series to which rubber is very closely related, if not actually a member, as was held by Weber. Many organic compounds, the terpenes in particular, possess the property of becoming resinified by oxidation in the air or under the influence of chemical reagents. In other words, they may be converted to substances very similar to the resins which occur in nature. The natural resins are solid, amorphous, and generally brittle masses which break with a conchoidal fracture. They are insoluble in water and acids, but soluble in acetone, alcohol, ether, turpentine, etc. They are found in the solid form in abundance and occur also as balsams; that is, dissolved in terpenes or ethereal oils from which they can be separated by steam distillation. Resins dissolve in alkalies to form resin soaps but are precipitated when the solution is acidified. Most resins consist of a mixture of somewhat complicated acids, the so-called resin acids.

The resins of rubber are extremely complex and are but very imperfectly understood. Neither their origin nor their composition are definitely known. The only way in which they can yet be safely defined is that they are substances which may be extracted from crude rubber by acetone or alcohol, and contain varying amounts of oxygen.

In regard to the relation of resins to rubber, only three views are possible:

- (1) They are derivatives of rubber, oxidation products, etc.
- (2) They are terpene bodies of low polymerization.
- (3) They were produced by the plant at the time of the formation of rubber but by different reactions and are not related chemically to rubber.

The first view, i.e., that they are derivatives of rubber, is the one most generally held and is probably correct for high-grade rubbers, notably those obtained from *Hevea brasiliensis*. Tschirsch¹ states that the carbon and hydrogen in resins frequently stand in the same relation to one another as in rubber, which, since all resins contain oxygen, would indicate that they are oxidation products. Perhaps the best argument, however, is that the resins of *Hevea* rubber protect it from oxidation and subsequent tackiness. When they are removed by extraction and the rubber sheeted out thin and exposed to air it quickly grows tacky. If it

is again extracted it will be found to have regenerated its acetone soluble content. Oxidation is accelerated by ultraviolet light. If a thin sheet of rubber is exposed to air in the presence of ultraviolet light it becomes tacky and has a higher resin content than before exposure. This view is not concurred in by Hinrichsen and Marcusson, and probably will never be accepted as a general rule applying to all rubbers.

The second view is perhaps correct to a limited extent in all varieties of rubber. Probably when we understand the mechanism by which the plant produces caoutchouc we will be able to throw more light upon this theory. Many rubber resins, i.e., the acetone-soluble portion of rubber, are made up of two parts, a soft and a hard resin. These may often be separated by steam distillation, etc. The inference is that they are similar to the balsams which consist of a resin dissolved in an essential oil. The hard portion is likely an oxidation product of rubber similar to Spillers resin, $C_{10}H_{16}O_2$ or a separate substance produced by the plant by some other reaction. The soft material is probably a terpene with a low degree of polymerization, i.e., $(C_{10}H_{16})_n$ where n is very small.

The third theory is applicable to the resins obtained from highly resinous rubbers, particularly those obtained from Dyera varieties such as Jelutong, Pontianac, Dead Borneo, etc. In these varieties the function of the plant seems mainly to have been the production of resin with rubber merely as a by-product. Hinrichsen and Marcusson² attacked the question by investigating the optical properties of resins obtained from various rubbers. They found that all varieties examined except *Hevea* resin were optically active and dextro rotatory. They deresinated a sample of Funtumia rubber and exposed it to the air, bringing about oxidation and tackiness. On again deresinating they obtained 3.11 per cent of an inactive resin. The rotation for natural Funtumia resin is $[\alpha]D + 32.9$. They concluded that since the oxygen derivative of rubber is optically inert this must be inert also and the active resins can not possibly be rubber derivatives. Optical activity is a characteristic property of the terpenes and the activity of natural resins is probably due to the presence of a small amount of such bodies.

PROPERTIES OF RESINS

Resin Content of Various Rubbers: The percentage of resin varies with the variety of tree and the care with which the rubber has been prepared. In general the more careful the coagulation the lower the resin content. Table I contains the resin contents and washing losses of certain rubbers as given by Spence³.

¹Die Harze, 1906, vol. 1, p. 989.

²Z. K. angew. Chem. 23, 1910, p. 49.

³Proceedings, International Rubber Congress, 1914.

Many others could be given but these are perhaps the most important. It should be mentioned here that Guayule and Jelutong (including Dead Borneo and Pontianack) where the only varieties ever deresinated on a commercial scale. The extraction of Jelutong yields such a large quantity of resin and so little rubber that it was early abandoned, at least as a source of rubber. The resin is valuable for certain purposes, and odd lots still find their way to the market.

Ozonides of Resins: Harries⁴ states that a characteristic property of rubber resins is that they form ozonides insoluble in carbon tetrachloride and chloroform.

Melting Point of Resins: Most resins are liquid at ordinary temperatures. Ditmer⁵ reports the following melting points:

	Deg. C.
Congo Rubber.....	74
Borneo	92.5
Madagascar	102

Unsaponifiable Matter, Optical Activity, and Iodine Values: The work of Hinrichsen and Marcusson has been mentioned above. The values obtained by them are as follows:

	Unsaponifiable Matter in Resin	Optical Rotation	Iodine Value
Jelutong.....	100%	(a) D + 50.9	30.6
Cassia.....	92.6	Active	...
Pedang.....	90.2	Active	...
Guayule.....	78.2	(a) D + 12	...
Kickixia.....	74.0	(a) D + 32.9	...
Congo.....	56.0	(a) D + 12	...
Ceylon.....	20.8	Inactive	...
Para.....	15.0	Inactive	118.0

They found as a general rule that the more active optically the resin the more unsaponifiable matter it contained. The unsaponifiable matter in Upper Congo resin gave a rotation of $[\alpha]D + 24.5$, while the saponifiable constituent of the same resin gave only $[\alpha]D + 13$.

CHARACTERISTICS OF CERTAIN RESINS

Jelutong: Dubosc⁶ treated crude Jelutong with acetone and then with ether and obtained two products which after repeated crystallization were both shown to have the empirical formula $C_{m}H_{n}OH$. They differed as follows: Melting points 80°-82°, and 105° C.; boiling points 195°-200°, and 280°-290° C. respectively; also in their solubility in acetone and chloral, and in their behavior with nitric and sulphuric acids. Dubosc considers that there is a simple relation between cholesterol and purified Jelutong resins. He regards the latter as isomers of phytosterin or plant-cholesterol. Cholesterol gives a characteristic color reaction with propionic anhydride. A blue color is first obtained which soon changes to red, then to green, then orange and finally red. With acetic anhydride a violet color is obtained, which eventually turns black. The resin propionate has a melting point of 98-100° C. Cholesterol propionate melts at 98° C. The resin acetate melts at 110 to 112° C. Cholesterol acetate melts at 113° C. The resin acetate in common with cholesterol acetate is saponifiable with boiling water. The reactions of cholesterol and Jelutong resin with sulphuric acid are analogous. Potassium permanganate, chromic acid, and sulphuric acid oxidize cholesterol to acids soluble in ammonia. Jelutong, when boiled three or four hours

⁴G. 2, 1910, vol. xxiv, p. 850.

⁵G. 2, 1907, vol. xxi, p. 666.

⁶La Caout. et la Gutta Percha, 1911, 8, 5756-5761.

with the oxidizing mixture, is converted to cholesterol acid, which is easily separated by means of ammonia. Fractional extraction of Jelutong with acetone in a Soxhlet yields three distinct products, melting at 141° C., 115° C., and 103° C. A mixture of equal parts of the resins melts at 82° C. These bodies are isomers and have the empirical formula $C_{m}H_{n}O$.

Schidrowitz states that Jelutong contains a white crystalline hard resin soluble with difficulty in cold, but readily in hot absolute alcohol, and a soft yellowish resin very readily soluble in cold alcohol. Technically, hard resins are preferable to soft. A resin content up to 8 per cent is not serious if it is mostly hard. Funtumia elasticia, properly prepared, contains only hard resin. Schidrowitz is of the opinion that Jelutong resin is probably a compound of vegetable cholesterol with cinnamic acid.

The following analytical data was obtained by the writer on old Pontianack resin obtained in the open market:

	A	B	C*
Melting point.....	73° C	82° C	92.5° C
Acid value.....	3.5	4.1	None
Saponification value.....	70.0	48.1	28.1
Iodine value.....	45.2	44.0	.....
Acetone soluble.....	99.5	99.3	.....

* Reported by Ditmar for Borneo.

Guayule: The Guayule shrub, Parthenium Argentatum, contains 8 to 10 per cent of rubber based on dry material. The commercial rubber contains 75 per cent of rubber hydrocarbons. The dry plant, according to Alexander,⁷ yields about 6.5 per cent of a dark-green substance when extracted with acetone. Of this 54 per cent, 31 per cent and 15 per cent are successively dissolved on treatment with light petroleum, ether and hot alcohol. Of the three component parts thus separated 12.1 per cent, 7 per cent and 2 per cent consist of unsaponifiable matter. The acids produced by the hydrolysis of the extract include one melting at 119° C., which belongs to the cinnamic acid group and phenyl acetic acid. Weil states that he found cinnamic acid in products of hydrolysis of Guayule resin. The crude acetone extract on steam distillation yields a sesquiterpene alcohol melting at 127-128° C., which has a camphor-like odor.

On distillation with steam Guayule rubber yields from 1 to 4 per cent of a volatile oil (15° C. .8861) which is laevo-rotatory. You will note that Hinrichsen found the resin to be dextro-rotatory. This oil possesses a peculiar pepper-like aroma and consists almost wholly of hydrocarbons. On distillation at 17 mm. pressure it yields the following fractions:

	Per Cent
Between 50- 60° C.....	30.0
60- 80° C.....	20.3
120-160° C.....	24.8
Resinous residue.....	5

The first fraction is mainly l-pinene and the third a sesqui-terpene. No styrene is present. The above relates to the oil distilled from fresh Guayule. Oil distilled from plants which have been stored for several years contained much oxygenated material and while pinene was obtained no sesqui-terpene fraction could be isolated. The presence of volatile oil in Guayule is the cause of the difficulty experienced when the rubber was first used on an industrial scale, since it hinders vulcanization. The oil also causes trouble because of

⁷Ber. 1911, 4, 2320-2328.

its dissolving action on rubber during vulcanization. It tends to break down the rubber and depolymerize it. Guayule can be used in small quantities blended with other rubbers, but if it is to be employed alone it should be deresinated.

The following analytical figures are the average of results obtained by the writer with fresh Guayule resin over a long period of time:

	Per Cent
Iodine value.....	57.5
Saponification value.....	61.1
Acid value.....	20.5
Unsaponifiable.....	50.1

FUNCTION OF RESINS

In low-grade rubber the resin functions simply as a diluent. The rubber secured by deresination of Guayule, Pontianack, Jelutong, Palembang, or Dead Borneo is in every case of good quality, being about on a par with Brown Crepe. In high-grade rubbers, such as the plantation and Para varieties derived from the *Hevea brasiliensis* tree, the function of the resin is entirely different. The first effect is to protect the crude rubber against oxidation. Deresinated Hevea rubber when exposed to the air soon becomes tacky. The second is to assist in vulcanization. Deresinated Hevea rubber cured with sulphur requires a longer time or higher sulphur content than is customary. The acetone-soluble material from this variety of rubber is a good accelerator. The presence of resins is apparently necessary if the mineral accelerators are used. L. E. Weber⁸ was unable to obtain a good vulcanization with deresinated rubber, sulphur, and litharge. The presence or absence of resin has very little effect on the time of cure if organic accelerators are used. The accelerating effect of Hevea resin has now been shown to be due to nitrogenous matter which is soluble in acetone. The influence of proteins and other nitrogenous materials has been well discussed by Dubosc, Eaton and Grantham, Beadle and Stevens, and others, to whose writings the interested reader is referred.

FEASIBILITY OF DERESINATION

As indicated above, only low-grade rubbers were deresinated on a commercial scale; and of these only Guayule and the rubbers from *Dyera costulata* (namely: Jelutong, Pontiniac, Palembang and Dead Borneo) ever came into any prominence in this field.

Chute,⁹ in estimating the cost of deresinating guayule in 1909 by his process, to be mentioned later, assumed that a grade yielding 60 per cent of purified gum could be purchased at 30c. per pound. He placed the solvent cost at 3c. per pound and the working cost also at 3c. per pound. One pound of Guayule would yield .6 pounds of gum at a cost of 36c., which made the cost per pound of finished gum 60c. The market price of guayule is still around 30c. per pound, but of course solvents, particularly acetone, are much higher. On the other hand, however, chemical engineering practice has made great progress within the past nine years. With modern apparatus the solvent loss should be reduced almost to zero. Based on a process later to be discussed, using gasoline and acetone, the solvent loss was seldom less than 15 gallons of acetone and 44 gallons of gasoline per 1000 pounds of good rubber produced.

The supply of Pontianack is today almost exhausted. This is due solely to the wasteful and extremely primeval methods used by the natives in securing the gum. Where they might have tapped trees and built up a steady business they felled and bled them at many different points. The method produced quick results but the procedure reminds one of the old fable about killing the goose that laid the golden egg. In 1909 a good grade of Ponti could be secured at 5c. per pound. The market price is now around 30c. per pound, making Ponti no longer a profitable purchase.

Chute⁹ in 1909 estimated the cost of deresinating Ponti as follows: "Assuming that Pontianack can be bought for 5c. per pound and that it yields one pound of purified gum from ten pounds of the crude, then the materials cost (by his process) for the rubber will be 50c. per pound for the finished product. If one gallon of solvent per pound of crude gum is used and the solvent is worth 75c. and the loss is one per cent, then the cost for loss of chemicals calculated on the finished product would be 7.5c. per pound. The cost for labor and other expenses for a moderate-sized factory should not exceed 5c. per pound of finished product. This would give a total cost per pound of 62.5c." Chute based his estimate on the use of certain methyl and ethyl esters, but the figures are typical of results obtained in the past.

The deresination of Ponti is now not to be thought of, but aside from patriotic reasons the treatment of guayule should be a good business proposition. It is not nearly so difficult as the treatment of a low-grade gold ore. There is no reason why it cannot be successfully and profitably accomplished if suitable chemical engineering talent be obtained.

Statement of the Problem:

1. To deresinate guayule, one must reduce the resin content from approximately 25 to about 2 per cent.
2. The rubber must not suffer in quality by excessive heating or by detrimental action of any solvent or reagent.
3. Solvent and rubber losses must be kept as low as possible.
4. The operation must be accomplished in as short a time and with as few treatments as possible.

Processes: Many processes have been proposed in the past. They may all be classified under the following heads:

1. Those which depend on the action of alkali on the resins.
2. Those employing a mixed solvent which at high temperatures will dissolve rubber, but at lower temperatures is a better resin solvent.
3. Those processes which use a rubber solvent for dissolving both rubber and resin and then precipitate out the rubber by adding a resin solvent in which rubber is insoluble.
4. Those which first extract the resin and later remove the rubber from woody material, such as occurs in guayule, by a suitable rubber solvent.
5. Those which employ a solvent for resin without at any time dissolving or otherwise affecting the rubber.
6. Those which use a mixed solvent consisting of a rubber and a resin solvent. The first swells the rubber and the second removes the resin.

⁸Eighth Int. Cong. Applied Chem., 1812, vol ix.
⁹H. O. Chute, "Desresination of I. R.," *I. R. W.*, June, 1909.

1. Alkali:

Processes using alkali depend upon the fact that certain of the rubber resins are partly saponifiable. Guayule resin, as reported by Hinrichsen (see above), is about twenty-two per cent saponifiable. Chaplet and Rousset¹² state that washing rubber with alkali after deresination removed some albuminoids and oxydases which would otherwise turn it black and oxidize it. Treatment with alkaline solutions is not a practical proposition; first, because it removes only a small part of the resin; and second, the removal of all the alkali is almost impossible. Even traces of caustic behave as unregulated accelerators, causing the stock to harden up and surface check on standing.

However, the first deresinating patents granted in this country were to Austin Day¹³ in 1856 for purifying rubber gums by treatment with alkaline solutions. In 1857 Roberts Haerting received U. S. Pat. No. 17,214 for purifying gutta percha by the action of an alkaline liquor which, as he claims, dissolves out the etheric oil. In 1903 W. A. Lawrence received a series of patents beginning with U. S. Pat. No. 741,256 covering the extraction of rubber from plants (guayule) by treatment first with naphtha and then with a solution of caustic soda. No. 741,258, issued August 20, 1902, refers to a process by which the rubber is removed from the plants by mechanical means and the resins then dissolved by alkali or alcohol.

2. Solvent which will dissolve rubber at high temperatures:

This method is really much better suited to gutta percha than to rubber. Eng. Pat. 22,758 was granted in 1901 to Combanaire and de la Fresnaye and covers the purification of gutta percha by treatment with naphtha which at certain temperatures dissolves gutta resins. A similar patent¹⁴ was granted to Wilmonsky in 1901 for a process of refining gutta percha, which consisted in dissolving the entire gum in hot gasoline and cooling to 60° F. when it was claimed if four gallons of naphtha or more were used for each pound of gum a flocculent precipitate was formed which consisted of pure gum.

Under this head may also be placed those processes which use pyridine. U. S. Pat. 983,812 granted to Drefus, Friedl and Bentley in March, 1910, describes a process wherein crude rubber is treated with six times its weight of pyridine base oil (boiling between 130 and 220° C.) and an equal weight of water. The mixture is agitated and heated to about 100° C. under a reflux condenser for 2 to 4 hours. Owing to the fact that pyridine even at this temperature dissolves appreciable quantities of rubber the process was never a commercial success.

3. Dissolve both rubber and resin, then precipitate the latter:

In February, 1906, a German patent was granted to Gratz covering a process in which the crude rubber was treated with benzine, turpentine, carbon bisulphide or gasoline, which dissolve both rubber and resin. The rubber is precipitated by the addition of methyl, ethyl or amyl alcohol which holds the resins in solution.

U. S. Pat. 978,696 issued to L. H. Chanut in June, 1910, describes the successive treatment of crude gum

with carbon bisulphide and acetone. For 100 Kg. of crude in all 227.5 litres of carbon bisulphide and 334.1 of acetone were required. The gum was first worked in a dough mixer with 50 litres of carbon bisulphide; later 40 litres of acetone were added and mastication continued. The mixture of solvents was poured off, 97.5 litres of CS₂ added, and mastication resumed. After a time 50 litres of acetone were added, thus precipitating the rubber. The solvents were poured off and 20 litres more of acetone added, which was poured off after a brief mastication. The third and fourth treatments began with 40 litres of CS₂, followed by 56 litres of acetone. The mixed solvents were poured off and 56 litres of acetone added in each case as a sort of after-wash to remove resins and granulate the rubber.

Another process belonging in this group is that of Lawrence,¹⁵ in which guayule which had been previously removed from wood by solution in naphtha was treated with alcohol which precipitated the rubber and dissolved the resin. After thoroughly washing the rubber to remove the last of the resin the solution was evaporated, leaving the resin behind in the kettle.

4. Extraction of the resin, followed by removal of the rubber from the wood:

This process is the opposite of that of Lawrence mentioned above. Foelsing¹⁶ proposed to extract the ground Guayule shrub with acetone followed by removal of the rubber by solution in naphtha. The solvents were removed by evaporation.

Both these processes are of rather questionable value owing to the fact that they could only be carried on in the region where Guayule is harvested, which territory is not very satisfactory for extensive chemical operations. The solution processes for separation of rubber from Guayule shrub have nearly all been abandoned in favor of mechanical methods.

5. Extraction with a resin solvent:

These processes are modifications of analytical procedure for determining the percentage of resin in crude rubber, which subject was investigated by C. O. Weber,¹⁷ who concluded that acetone is the most satisfactory resin solvent, and states that it will, particularly at higher temperatures, easily dissolve all the resinous constituents of rubber, gutta percha, and balata without dissolving a trace of any of these bodies themselves. The processes under this head involve the extraction of rubber with acetone, alcohol, or other resin solvent which does not attack the gum.

The first patent granted in this country in which definite claim to deresination of rubber was made, was the one previously mentioned which was granted to Lawrence¹⁸ in 1902. It involved the treatment of guayule containing some naphtha with alcohol. The extracting plant consisted of a churn which was provided with a corrugated bottom with corrugated rollers which in passing over it masticated the rubber in the presence of the solvent. The saturated liquid was removed to a still, the acetone and naphtha evaporated and run into tanks for further use, leaving the resin behind.

A process closely related to analytical practice is that of Eves¹⁹ in which a car containing rubber is exposed

¹²LeCaout. et la Gutta Percha, Feb. and Mar., 1911.
¹³U. S. Pat. 15,067.
¹⁴U. S. Pat. 673,520.

¹⁵U. S. Pat. 741,260, Mar. 1902.
¹⁶French Pat. 368,958 (1906).
¹⁷Chemistry of India Rubber.
¹⁸U. S. Pat. 821,934, issued 1906.

to the vapors of alcohol or acetone which pass through and around the mass which is worked by rotating arms within the car. The condensate falls from the condenser upon the rubber, thus giving extraction at or near the boiling point of the solvent, which point was particularly recommended by Weber.¹³ At least one large plant was successfully operated under the Eves patent and several hundred tons of rubber were treated by this process.

Practically all deresinating plants in operation in this country in 1912 used acetone as the resin solvent. Of particular interest now are the patents of Chute¹⁴ which cover the use of the acetic esters of ethyl and methyl alcohols. He states¹⁵ that acetone will dissolve when hot only 18 per cent of Pontianack resin, some of which will crystallize out on cooling. Methyl acetate dissolves 25 per cent of the resin and ethyl acetate 50 per cent. These esters were used in conjunction with acetone. In other words, Chute discovered a mixed solvent which has no effect on rubber but holds a high percentage of resin. The chief objections to the use of these esters are their high price and the relatively small quantities available. Solvent loss was formerly quite a factor, but with modern apparatus this should be reduced to a negligible factor. If deresination by means of a resin solvent is decided upon the mixed solvents of Chute would probably be superior to acetone since smaller volumes of solutions could be handled, requiring less equipment and giving a lower solvent loss.

6. Two solvents, one to swell the rubber, the other to dissolve the resin:

The processes which come under this head were in general use and a rather large volume of deresinated Guayule was prepared in this way. The resin solvents employed were chiefly alcohol or acetone, while gasoline was used almost entirely for swelling the rubber. They were combined and used as a mixed solvent. The usual proportions were 47 per cent gasoline and 53 per cent acetone by volume.

You will note that the Lawrence¹⁶ patent also comes under this classification. The idea is indicated, though rather imperfectly described, in French Pat. 404,307 (1909) to the Caoutchouc Co., which describes a process in which a little benzine is added to soften and swell the rubber to the gelatinous condition but not enough to dissolve it, after which acetone was employed to remove the resins. The process described later in this paper also comes under this classification.

Apparatus: All those who are familiar with the preparation of rubber cements realize that no solvent can properly act on large masses of rubber without constant mastication. This principle is of the greatest importance in deresination, no matter which process is used. Means must always be provided for bringing the solvent in intimate contact with the rubber. The closed vessel in which the rubber and solvent are worked together, usually by rotating arms or rollers, is called the churn.

U. S. Pat. 821,717 was issued to F. C. Hood in 1906 for such an apparatus. A set of ordinary rubber washing rolls were mounted in a water-tight covered chamber which was filled with deresinating liquid to a point above the rolls. The sheet of rubber was made to pass through the rolls, then up and through once more,

There is also a patent to Lawrence,¹⁷ previously mentioned, for a corrugated roller passing over a corrugated bottom.

Whether the treatment in the churn is continuous or intermittent, the solvent soon becomes charged with resin from which it must be separated by distillation. A still has been designed for this purpose by Chute¹⁸ with the special purpose of preventing foaming, which would carry some of the resin into the distillate. It is a combination of a chambered column still, provided at its base with a quieting and settling chamber which is connected to a sort of boiler through a large tube. Vapor from the boiler enters the settling chamber near the top.

Chute¹⁹ has worked out a process which is especially suitable for his mixed resin solvent, i.e., acetone with ethyl or methyl acetate. The apparatus comprises a series of extractors provided with means of heating and mastication. The solvent is admitted to the extractors on the counter current principle, with a view to treating the rubber in each at least four times or more. The process permits the treatment direct of crude rubbers without drying, since it has been found cheaper to remove the moisture by use of solvents than by drying in the ordinary way. Price calculations on Guayule and Pontianack have been previously discussed.

(To be Continued)

Chemists to Discuss War Necessities

Coincident with the Fourth National Exposition of Chemical Industries to be held in Grand Central Palace, New York City, during the week of Sept. 23 will be held various conventions of chemical and technical organizations. The meeting and programs will reflect the strides made by the chemists of America during the past year. The exposition also will show the people of the country the remarkable expansion which the chemical industry has undergone, as it will be necessary to use four floors of the building for the exhibits.

The exposition is a war-time necessity; and regarding it as such each exhibitor is planning his exhibit so that it will be of the greatest benefit to the country through the men who visit it, all of whom are bent upon a serious purpose—that of producing war materials in large quantities, and constantly increasing this production till the war has been won by the United States and its allies.

Papers covering practically every phase of chemistry and a discussion of steps that will need to be taken after the war will be presented by leading experts in each branch. Pressing chemical problems concerning many of the chief articles of domestic and foreign commerce will be taken up during the convention, and it is expected that these discussions will have an important bearing on the future manufacture of materials that have been scarce and high-priced ever since the curtailment of American commerce with Germany and other European countries. In order to fill the demands for chemicals hundreds of factories have sprung up in various parts of the country, and while doing a large business, it is pointed out by experts that there is a lack of preparation to meet new conditions which are bound to follow at the close of the war.

¹³U. S. Pat. 845,616 and 890,217, 1907 and 1908.
¹⁴H. O. Chute, *India R. World*, June, 1909, and July, 1911.

¹⁵U. S. Pat. 896,434, issued Aug. 18, 1908.
¹⁶U. S. Pat. 890,216, issued 1908.

The Human Element in the Mill

Influence of Competition on Process Control Records—Importance of Automatic Recorders and Working Diagrams—Creation of Research Initiative

MANY important ideas of vital interest to mill executives were brought out in the opening address by HUGH K. MOORE at the tenth annual meeting of the American Institute of Chemical Engineers. Mr. Moore spoke of the relation between manager and employee. The following extracts are printed verbatim from the address which will be published in full by the society in the 1918 annual.

IMPORTANCE OF MENTAL CONTACT BETWEEN MANAGER AND MEN

If you only know what the men think you may be able to make explanations which will enlighten them and give them a different outlook on life. The closer the personal touch between the employer and employee the less is the chance for misunderstandings and the better for both employer and employee.

Do you realize that a man may put down figures which he knows are not the truth and yet never have it enter his mind that he is sophisticating his results? This is not dishonesty because he does not perceive there is any dishonesty in what he has done.

An example of this may be taken from our 1908 records. The operation is burning sulphur with air with the intent of getting the highest possible percentage of sulphur dioxide in the resulting gas. The records on our books show the following results as obtained from hand-fired flat burners used at that time.

PER CENT SULPHUR DIOXIDE GAS		
Shift 12 N. to 8 A.M.	8 A.M. to 4 P.M.	4 P.M. to 12 N.
15.8	15.6	16.5
15.0	18.4	14.6
16.6	16.3	11.6
15.8	13.9	17.3
15.8	16.3	16.6
15.8	15.3	17.3
15.8	16.2	17.2
15.0	17.2	16.1
14.0	12.6	16.4
16.4	15.3	....
Average 15.6	15.7	15.9

You will see from the above that there is not very much difference between the maximum and minimum readings.

To show that the above is not a true statement of facts, I submit Chart I giving the analyses from a recording machine. It will be observed that the figures given in the above table are only the maximum figures. You see every time the burner doors were opened the large influx of air weakened the gas. Now every foreman soon found out that after a certain time had elapsed after firing, the gas would test a maximum and not sublime sulphur. He always planned then to be on hand at this time to test his gas and actually put down the figures he found by analysis. This in all probability started from one foreman doing this and when the other foremen did not get equally good results they copied the same method. Now these men were not scientifically trained, and when they averaged up their selected results there was no thought in their minds that they were

of no value whatever. Furthermore the management, on going into the mill and seeing the foreman write down the selected results which he could see were actually obtained on the Orsat, had no suspicion as to how far they were incorrect. Had he known what the men were thinking about he would have been "put wise," and would not have accumulated on his books an amount of data which was absolutely valueless. At this time we had installed an automatic recorder. The recorder record of the same shifts shows far different results though the maximum results are approximately the same. Comparing the two we get results as follows:

PER CENT SULPHUR DIOXIDE		
	Foremen	Recorder
Shifts 8 a.m.-4 p.m.	15.7	11.5
Shift 4 p.m.-12 n.	15.9	13.1
Shift 12 n.-8 a.m.	15.6	12.9

Incidentally this illustration shows the value of an automatic machine which records at given definite intervals. Even had the management known of these variations it would have been unable to time the analyses of the different foremen periodically so as to get true concordant results. In the case above (which is given not as an isolated case but as an example of a type) we have an illustration of ignorance, combined with the idea to make as good a showing as possible based on the more or less ever present feeling of self-preservation. Where the superficial observer would have classed the foreman as dishonest the careful observer cannot overlook the psychology involved. It sometimes happens that the management expects too much of the men. By this I do not mean to state that he does so purposely; in fact, he is unaware that he is expecting too much. He probably does not know the complexity of the problem involved and what is more even if he were on intimate terms with his employees he could hardly find it out as they do not know themselves just what is involved and cannot make it clear to their employers. Here is where the chemist or chemical engineer comes in. He, however, should be democratic, of sterling character, and in full sympathy with his fellow beings. He can then obtain from them what information they can impart and with his more technical knowledge reject that which is bad and adopt that which is good. Above all he should not be a man, "who knows it all." The man who goes around with the air of "I know it all" engenders antagonisms and often contempt and discourages suggestions. He may defeat by this attitude the main object of accomplishment which is his task.

The man constantly with a process or apparatus finds out many details of operation which one who is not constantly in touch with it (no matter how able he is) will hardly find out at all. In my experience in mill work I have never run across a man operating a process or device that could not show me valuable points. A lot of opposition to changes which the man-

agement wishes to make may be traced to the fact that the management has not taken care to collect the valuable data which their employees have. They consequently do not know what their men are thinking.

As an illustration I know of a manager who, noticing that knots and bark sank while chips of clear wood floated, designed a process for their separation by flotation. He told the foreman of his scheme who promptly told the manager it would not work, at least not to such an extent as to make it practicable. The manager, an educated man, thinking it was the ever-recurring opposition to innovations, turned on his heel and left the foreman without asking for an explanation. He constructed his machine, installed it, and tried to operate it, and on finding that it would not work finally destroyed it. Later he called the foreman and asked him how he knew it would not work. The

sum of these is also plotted. By plotting in this manner we can illustrate our point and yet simplify the matter to such an extent that it is readily understandable to those who have not, so to speak, made a profession of the study of numerous and complex graphs.

The efficiency curve is the only one known to the foremen and the dotted lines were known only to the investigators. Smith, Brown and Jones are fictitious names.

To the foremen the efficiency meant the amount of water evaporated per pound of coal and this was arrived at by metering the water into the boiler and dividing the same by the pounds of coal used.

It will be seen from the above chart that Smith was an honest man and the amount of heat accounted for did not ever get to an amount over 100 per cent of the heat in the coal that could be accounted for,

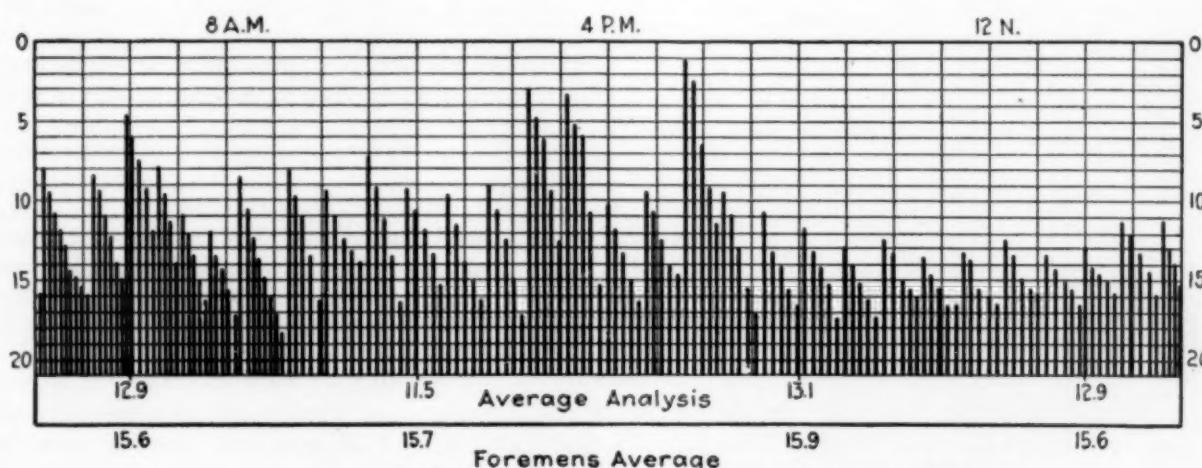


CHART 1—ANALYSIS OF RESULTS FROM A RECORDING MACHINE

foreman took a piece of wood floating in the wood-room tank and cut many chips from the same. They, when thrown into the water, went to the bottom. This foreman from his daily work had observed certain facts which had escaped the attention of the manager. This manager made the mistake of underestimating the intelligence of his foreman. Some see and remember the minutest details, while others may miss these entirely and pay attention only to the principles involved. The strict observance or non-observance of detail is often, in fact is generally, the difference between success and failure, provided your basic principle is sound.

In the illustration before given we have shown a typical case wherein men put down results which they knew did not represent the facts and were entirely honest in what they were doing.

I am now going to give a typical example of wilful sophistication and will illustrate it by Chart 2 which shows more or less accurately the efficiency of the foremen on each shift in the boiler house. This chart is only illustrative, for in order to save space and in the interest of lucidity it is condensed in time and all the factors are not plotted; radiation, convection, the necessary blowage, etc., are not plotted but lumped together in a constant called radiation 5 per cent.

The stack losses and the ash losses and the efficiency of the boiler are plotted all in terms of the percentage of B.t.u. contained therein of the original coal, and the

save by errors in observation and calculation. On the fourteenth and fifteenth day Jones probably, by accident rather than design, blew off more water than was customary. On the sixteenth and seventeenth he ran normally and probably cogitated on the fact of his high efficiency. In his cogitations it occurred to him that he had blown an unusually large quantity of water when he obtained a high efficiency and from then on Jones purposely blew an ever-increasing amount of water through the blow-off.

Brown also had been cogitating over the high efficiency of Jones and finally gets wise but he overdoes it and his efficiency jumps to 86 per cent. Now the graphic department in plotting all the curves noticed that the total B.t.u. accounted for reached as high as 110 per cent of the B.t.u. in the coal. They report it to the chemical engineer and he sees where the plant is not complete and perhaps he talks with Smith. At any rate, on the twenty-seventh he installs a tank capable of standing the full pressure of the boiler and pipes the blow-offs of the boiler to this tank. By this means certain deductions can be made and the efficiency as figured from the input of water to the boiler is corrected. It will be observed that the efficiency of both Brown and Jones dropped while that of Smith did not change upon installing the tank.

I have given an example of the management underestimating the intelligence and powers of observation of the employees. To underestimate the difficulties

encountered by the men, while perhaps not of as great importance as the foregoing is still of sufficient importance to warrant its mention.

WORKING DIAGRAMS

In all probability most chemical and metallurgical operations are carried on by men who have had no training in chemistry or metallurgy. By long experience a man may obtain a technique which will enable him to carry on an operation successfully even though it may be complicated by many variables. Now if these men are organized they may, if they so desire, exert a pressure on the mill management all out of proportion to their numbers. This is especially true if the operation they control is a fundamental part of the operation of the plant. I have seen the time when six men not only had the power but exerted it to shut down the largest mill of its kind in the world. Realizing this fact, they made most exorbitant and

pressure. When we first started this system we found it very difficult to make the men understand that a pressure below atmospheric pressure was a real pressure, so we plot those pressures below atmospheric pressure as minus pressures, and a table of the pressures corresponding to temperatures of steam is given to every cook. Thus, 158° F. would show as pressure on this chart as -10 pounds while 250° F. would show as +15 pounds. Now the gage pressure¹ is plotted and the steam pressure¹ corresponding to the temperature is also plotted. The difference between these two is the gas pressure which is also plotted. Then inasmuch as it is the SO₂ gas which does the cooking this picture shows the cook if he is blowing off his gas too fast. The crosses on the chart are given in place of figures for the reason that we are dealing in principles and it is not our object to give away private information of the mill. The cooks are taught to plot these charts themselves and in so doing they correct their cooking procedure. Having established the value of the chart we at once placed ourselves in a position to demand uniformity of results. This example is an illustration of how the management formerly expected too much of the men, when they asked for greater uniformity of results than they got.

This chart has another value in that it is now possible to do experimental work in the laboratory and draw the desired chart which we may reasonably expect the cooks to duplicate in practice.

CREATING TECHNICAL INITIATIVE

There is a great tendency in manufacturing plants to hide the light of employees under a dark bushel basket. This is a narrow and shortsighted policy and while the management may save a few dollars in salary the intangible loss far outweighs the small amount saved.

As an illustration of what I mean I may give the policy of our own research laboratory as compared with the general attitude of laboratories over the country. When we hire a man we try to impress upon him that in considering his compensation he should not consider his salary as his total compensation. The reputation which he is enabled to make is as much a part of his compensation as his salary. We do not stand in the way of a man obtaining a wide reputation; we even aid him to get the same. This not only gives him an idea of what he is worth by enabling him to receive offers from the outside world which he otherwise would not have received, but it also informs the management that if he is worth so much to an outside organization he is worth as much or more to our organization. You will say, "I can see how this benefits the employee, but how does any such policy benefit the mill?" The answer is that such a policy tends to produce what I may term the Stimulation of the Initiative. And above all this policy tends to create respect and con-

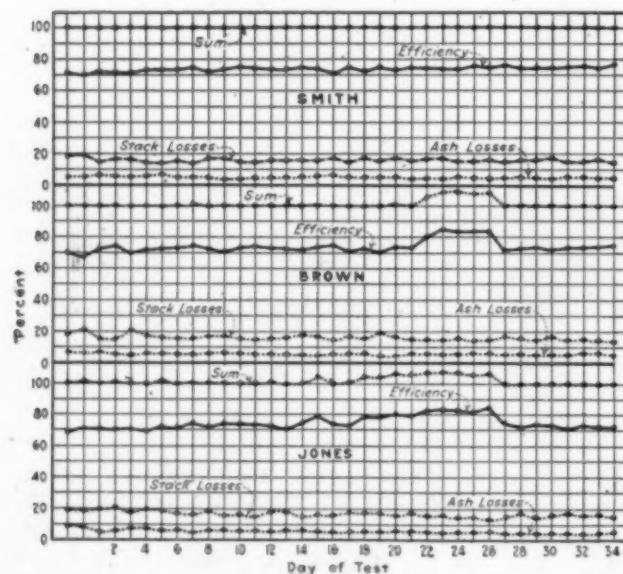


CHART 2—BOILER PERFORMANCE CURVES FOR THREE FOREMEN

unscrupulous demands. Here again had the management possessed the information which the men had obtained, this thing would have been impossible. Now here is an operation containing many variables with the possibilities of spoiling a cook far in excess of the possibilities of making a cook, and with so many variables the probabilities are that though they may get by on making the cook, the products of separate cooks are not uniform but may vary greatly. Now if you want a carpenter to make a house you do not cut all his lumber for him and tell him "Everything is ready, now build your house." The carpenter would tell you to give him the picture or plans of the house and he could cut the lumber himself.

In the same way the operator of a complex chemical operation would like if it is possible to obtain a picture or plan of this operation. The more complex the operation the more ingenuity must be exercised to obtain a picture which means something. As an illustration, Chart 3 shows an actual digester cooked in 1911. On this chart the ordinates are pressures and the abscissæ are time in hours. The three pressures plotted are gage pressure, steam pressure and gas

¹It will be observed that the steam pressure and gage pressure are on a different scale from the gas pressure and to this extent the chart is deceptive to the eye. To make these on the same scale the gage pressure and steam pressure should be 14.7 pounds higher.

Just how this came to be plotted this way I do not know. However, the gas pressure is correct, which, of course, is the main thing. The cooks have formed the habit of making charts this way and as a change of chart to a more scientific scale would not in the end enable them to make better cooks and would during the process of changing tend to have them make worse cooks, it has not been thought advisable to make the change.

fidence which are the foundation stones for loyalty and good service. We find first that the policy outlined not only informs the employer what he is worth but it informs the employee. It is very natural that an employee should get an exaggerated idea of his own importance. If, however, he finds that others besides his employer do not accept him at his own valuation he will modify his ideas. He can no longer take the attitude that if he could get out into a wider world that he would be more appreciated.

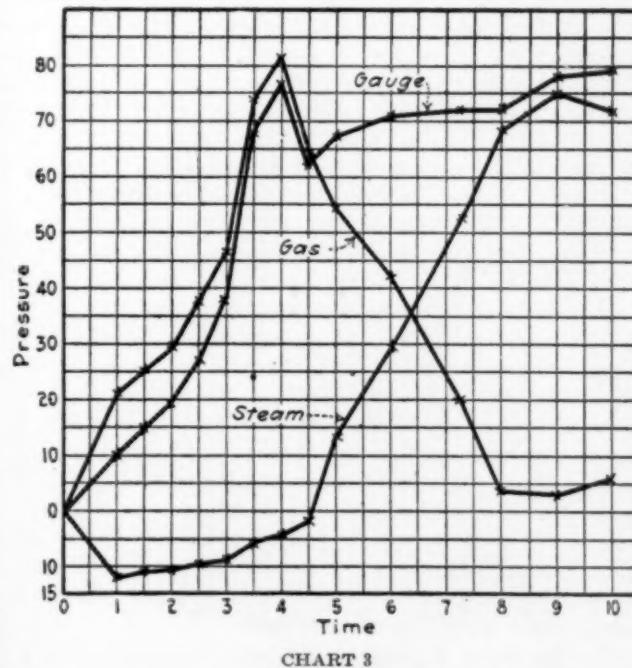
His reputation is what he makes himself and he receives full value according as he makes his reputation. Having now obtained a more or less true estimate of his own value he immediately starts to build up for himself a reputation and this can only be done by rendering valuable service. Here then may be a starting point for the development of the initiative. But it is not sporadic attempts which cause development; it is the constantly exerted force of the will which must be applied to allow physical growth to take place with the consequent mental growth. A dissatisfied employee will never exert the constant effort of the will to develop, even though it be in his own interest as well as his employer's. As an example of the application of the following principles I wish to state that in one of our mills our chemists began to develop the much-desired ~~spirit~~ ^{drive}. I was called away and was constantly out of touch with these men for four years and did not see ^{as} much of them for two years more. During this time the man to whom they were directly accountable also tried to develop in these men the personal initiative, but defeated his own purposes by not giving the men the credit which was theirs.

Instead of taking out joint patents with these men he took them out in his own name, and while he talked and lectured on mill organization he never gave due credit to those who helped in this work, and while as a rule he did not claim directly all credit for this work, he nevertheless got the entire credit by implication. The result of this procedure was the entire destruction of the incentive, which stopped the development of the initiative. During this entire time there is no credit to this concern for patents taken out by these men, neither so far as my knowledge goes are there any publications by which these men could receive due credit from business men and others in their profession for that which they had accomplished. It is our problem to make conditions such as to recreate as far as possible the lost initiative. This is a far more difficult problem than formerly because the nerve tissues are less plastic and less susceptible of change by excitation than was their condition eight years ago. In the formation of habit it is essential as far as possible to avoid misdirected habit which becomes more or less of a stumbling block. Right here I wish to state that it is a great mistake to put a man in charge of the execution of a problem on which he has formed the preconceived opinion that its successful solution will be impossible. The successful solution of a problem may or may not be possible, but if you have determined to try and solve this problem after hearing all arguments pro and con, then the way to start is to put its execution in charge of a man who is an optimist as far as this particular problem is concerned. Here again we have an illustration of habit.

Every failure of the man who believes this cannot be done, and there will be many, will only tend to confirm him in his preconceived belief that it cannot be done, and repeated failures simply stimulate the habit of disbelief as far as this problem is concerned. We have seen a very good illustration of this principle in the

1907 MILL COOKING REPORT

Cook No. 56	Hrs. after Steaming	Time	Tem- perature	Gauge Pressure	Steam Pressure	Gas Pressure	Percent SO ₂
Digester No. 6	0	6					XXX
Date, 1907	4	6.30					XXX
Filling Time xxx	1	7	145	10	-11.3	21.3	XXX
Steamed at 6 a.m.	1 1/2	7.30	151	14	-10.8	24.8	XXX
Blown at 4 p.m.	2	8	157	10	-10.3	20.3	XXX
Hours Cooked 10	2 1/2	8.30	161	28	-10-	38.0	XXX
Steamed by xxx	3	9	170	38	-9	47.0	XXX
Blown by xxx	3 1/2	9.30	190	68	-6	74.0	XXX
Blowing Test xxx	4	10	195	77	-5	82.0	XXX
Acid Temp. xxx	4 1/2	10.30	207	62	-	64.0	XXX
Test: Total xxx	5	11	246	67	13	54.0	XXX
Free xxx	6	12	272	71	20	42.0	XXX
Comb. xxx	7 1/2	1.15	290	72	52	20.0	XXX
	8	2	315	72	60	3.0	XXX
	9	3	321	78	75	3.0	XXX
	10	4	318	78	72	6.0	XXX
	11	5					XXX
	12						XXX



last three years. We had such a problem and the superintendent of one of our mills put a man of marked ability in charge of its execution. The marked ability of this man was recognized by the government sending him to France, putting him on General Pershing's staff as a chemical engineer with the rank of captain. Nevertheless he was a pessimist as far as this problem was concerned and nothing but discouraging results were forthcoming. When he left, the solution of this problem was sought by the same staff with the exception of this man and solved with the greatest success. The remark which he made upon being told of the successful solution of the problem, viz.: "I am from Missouri, you will have to show me," illustrates his mental attitude as far as this problem is concerned.

Now when you realize that mental growth is the product of constant application of the mind, you will readily see that the management, if it gives up a problem too soon, before opportunity for mental development has had a chance to take place, makes a great mistake.

I worked on one problem off and on for seven years; on another problem I worked three years and on the one just mentioned over three years. Two is a short time to solve a real big problem. Now from what has been said it will be seen that the changing of an executive in charge of a problem, unless he proves himself radically unfit, simply because he does not arrive at the solution immediately is a grave mistake. The executive has this problem before him night and day and the constant excitation of this part of his brain is producing a slow but nevertheless sure development which, if the problem is not impossible, must lead in time to its solution. Now if constant changes are made among the men in charge the new man has to go through all his predecessor went through before he has reached the same mental development. If then other changes are made the foregoing is repeated and the management has nothing to its credit but a large experimental expense. The management should be careful in choosing the man who is put in charge, but having chosen a man it should continue this man on this problem until results are achieved or until it has made up its mind that a successful solution will not pay dividends on the amount of money required for its solution. As mills go, far too many problems are abandoned before a fair trial has been given, owing to the non-observance of these principles.

I have spoken here of the mental attitude of the executive in charge of the successful solution of a problem, and laid down the principle that he should be a believer in its successful solution from the start, and now I want to say one word as to the attitude of the management in regard to suggestions coming from those responsible to it. It must be constantly borne in mind that the management puts its capital in these operations and that it will suffer for all mistakes it makes as well as the mistakes of its employees and that consequently its decision should be final, good or bad. But it often happens that it can reap benefit from the mistakes it makes as well as penalties. The wise management will allow certain leeway (within certain limits) to its chief executives as they, after all, carry out the policy of the management.

For instance, a foreman may come to the executive with a proposition which that executive knows from past experience will not work. He may turn it down absolutely or he may consider after figuring it over that he will allow the foreman to try it and fail and convince himself. I have done this many times myself and have obtained results from the changed mental attitude of the men which far outweighed the small expense involved and sometimes I have seen how to make suggestions from the failure which may change the failure into more or less of a success. In case of foreordained failure, so to speak, I always put it up to the man himself and give him my heartiest support so that when it fails he can have no comeback. If, as sometimes happens, the management is mistaken and the man gets the solution, the executive should not be

grudging of his acknowledgement, but take off his hat to him, so to speak, in a wholehearted manner. This tends to produce not only co-ordination but co-operation and the *esprit de corps* which we are striving to obtain.

Gases Used in Warfare

In an article by Major S. J. M. AULD, entitled, "Methods of Gas Warfare," published in the *Journal of the Washington Academy of Sciences*, Feb. 4, 1918, the following list of gases is given as being used by the Germans in the present war.

1. Allyl isothiocyanate (allyl mustard oil) C_5H_9NCS (shell).
2. Benzyl bromide, $C_6H_5CH_2Br$ (shell).
3. Bromacetone, $CH_3Br.CO.CH_3$ (hand grenades).
4. Bromated methyl ethyl ketone (bromketone), $CH_3Br.CO.C_2H_5$ or $CH_3.CO.CHBr.CH_3$ (shell). Dibromketone, $CH_3.CO.CHBr.CH_2Br$. (shell).
5. Bromine, Br_2 (hand grenades).
6. Chloracetone, $CH_3Cl.CO.CH_3$ (hand grenades).
7. Chlorine, Cl_2 (cloud).
8. Chlormethyl chloroformate (palite), $ClCOOCH_2Cl$ (shell).
9. Nitrotrichlormethane (chloropicrin or nitrochloroform), CCl_2NO_2 (shell).
10. Chlorosulphonic acid, $ClSO_2Cl$ (hand grenades and "smoke pots").
11. Dichlorodiethylsulphide ("mustard gas"), $(CH_3ClCH_2)_2S$ (shell).
12. Dimethyl sulphate, $(CH_3)_2SO_4$ (hand grenades).
13. Diphenylchlorarsine, $(C_6H_5)_2AsCl$ (shell).
14. Dichlormethyl ether, $(CH_3Cl)_2$ (shell).
15. Methylchlorosulphonate, CH_3ClSO_3 (hand grenades).
16. Phenylcarbylamine chloride, C_6H_5NCCl (shell).
17. Phosgene (carbonyl chloride), $COCl_2$ (cloud and shell).
18. Sulphur trioxide, SO_3 (hand grenades and shell).
19. Trichlormethylchloroformate (diphosgene, super-palite), $ClCOCl_2$ (shell).
20. Xylyl bromide (tolyl bromide), $CH_3C_6H_4CH_2Br$ (shell).

Rulings on Importation of Magnesite and Manganese

The War Trade Board has amended the restriction upon the importation of magnesite to permit its importation, under the back-haul proviso, when shipped as return cargo from Europe and the Mediterranean coast of Africa, and when shipped from convenient ports where loading can be done without delay.

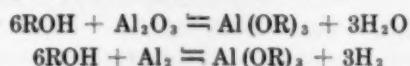
Importations of manganese ore from Asia and Australasia have, by another ruling, been prohibited as to ocean shipments made on and after July 20, 1918; and, to make this ruling effective, all outstanding licenses for the importation of manganese from those countries have been revoked as to ocean shipment on and after July 20, 1918.

Adequate supplies can be obtained, it has been found, from sources near by, entailing far less strain upon the tonnage resources of the United States during the present difficult period than shipments from the distant ports in Asia and Australasia.

Synopsis of Recent Chemical and Metallurgical Literature

Molybdenum Steel.—Discussing Dr. H. M. Howe's recent A. I. M. E. paper on "The Erosion of Guns", Mr. H. R. BATCHELLE said that ten years ago it would have been hard to determine molybdenum in steels containing considerable amounts of nickel and chromium. "A 1907 analysis of ferro-molybdenum by commercial methods gave what purported to be the following results: iron 92.55; carbon 5.64; molybdenum, trace. It subsequently developed that the 'carbon' was mostly molybdenum. The consulting chemist was C. T. Hennig, a former employee of Krupp, who represented them in this country in certain technical ways with special relation to molybdenum, chromium and manganese. The firm producing this ferro-molybdenum was offered a contract for the sale of its whole production to Krupp, who used it for ordnance purposes and would have been glad to get more. According to Hennig, the physical properties of the steel were improved by the addition of molybdenum just before pouring; he also said that analysis would often show only a trace of molybdenum in the steel, while the slag would be high and some molybdenum would be volatilized, especially if the molybdenum were added in the form of metal and not as ferro-molybdenum. When using the metal, it was, therefore, necessary to protect it from oxidation by plating, and silver plating was used successfully."

Corrosion of Aluminium.—At a meeting of the Society of Chemical Industry in London, Messrs. RICHARD SELIGMAN and PERCY WILLIAMS gave an account¹ of the reaction between aluminium and anhydrous organic hydroxyl compounds such as the fatty acids, phenols and alcohols. The effective protection from corrosion afforded by the thin coherent coating of Al_2O_3 on the aluminium is what makes this very reactive substance an industrially useful metal. As would be expected upon considering the reactions,



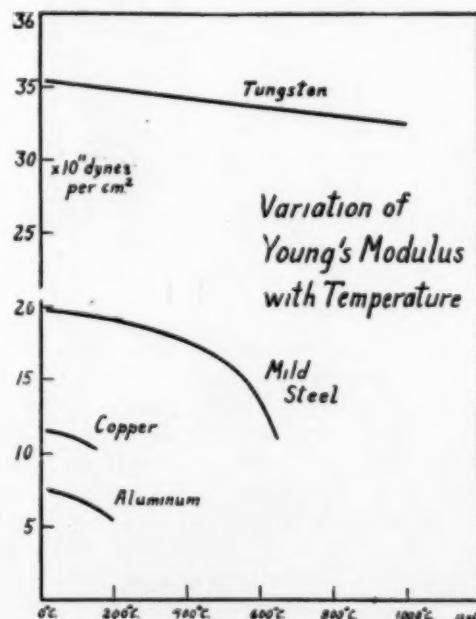
from the point of view of mass action, both of these would go to the right, were they initially started by decreasing the H_2O content to a sufficiently low point. Attention was brought to the subject by the failure of aluminium to resist corrosion in phenol concentrating distilling equipment. Some use can be made of this reaction for producing aluminium oleate, stearate, etc., as these acids, when anhydrous, react immediately with aluminium.

Corrosion of Lead.—In the discussion of the corrosion of lead before The Society of Chemical Industry² the fact was brought out that the sheet lead of old London roofs had decomposed where they were in contact with oak or portland cement. Condensation of moisture with wood acids and CO_2 produced re-

sults similar to the Dutch White lead process in the former case. In the latter, sufficient alkaline salts are present to change the metallic lead to plumbites and plumbates. At the present time, sheet lead for chemical work has from 6 to 10 per cent antimony alloyed with it to increase stiffness to prevent creeping. In acid work, fluorine and silica must be prevented from being present, since hydrofluosilicic acid violently attacks lead.

Aluminium in Germany.—Low grade alumina ores are reported as being refined at the Neuhausen Works by means of the Moscicki process, by which producer gas is used as a reducing agent with the formation of aluminium nitride. Upon hydrolyzing, pure alumina and ammonia are obtained as in the Sepek synthetic ammonia process. The alumina is then reduced in an electric furnace as usual. Perhaps some such process can be used for obtaining alumina from certain clays, such as halloysite, which is abundant in the United States, and, according to Mellor, decomposes into alumina and silica at 350 degrees Centigrade.

Variation of Young's Modulus with Temperatures.—H. L. DODGE has presented four papers in *The Physical Review*, second series, Vol. 2, p. 431; Vol. 5, p. 373; Vol. 6, p. 312; and Vol. 11, p. 311, on the relation existing between temperature and elasticity of copper, mild steel,



aluminium and drawn tungsten, respectively. In the last paper he describes a new electrically-heated tube furnace for the work whose construction approximates that of a black-body. The wire under test is observed through mica windows in the furnace wall. Preliminary experimentation consisted of measuring the coefficient of expansion (found to be 0.00000456 per degree C.) In measuring the modulus of elasticity, the wire was uniformly heated from end to end by the passage of a constant electric current, and the temperature determined by its thermal expansion. The value of Young's modulus at 20 deg. C. (35.5×10^{11} dynes per square centimeter) is lower than that given by Fink, but it is probable that tungsten wires prepared by different workmen differ that much in physical properties. The figure collects the results of all four metals graphically.

¹Journal of the Society of Chemical Industry, Vol. XXVII, No. II, P. T. 159-165, June 15, 1918.

²Journal of the Society of Chemical Industry, Vol. XXXVII, No. 2, p. T. 39, Feb. 15, 1918.

Recent Chemical and Metallurgical Patents

Distillation of Wood Tar.—ROBERT C. PALMER, of Pensacola, Florida, patents the process of adding to wood tar a suitable amount of water and chemical catalyst such as phosphoric acid, and distilling the mixture, whereat the complex combinations of phenyl, methoxyl, etc. radicals are hydrolysed to methyl alcohol and acid phenol, condensing the vapors and recovering a better yield of alcohol, acetic acid, phenols and tar oils. (Assigned to the public; 1,271,071. July 2, 1918.)

Manufacture of Alkali and Organic Chlorides.—K. P. MCELROY, of Washington, D. C., patents a process for the simultaneous manufacture of alkali and organic chlorides. A tank 20 (Fig. 1) is subdivided by diaphragms so as to make a succession of chambers containing anodes A of crushed carbon, cathodes C of wire mesh, and between each pair an electrolyte of brine. The electrolytic compartments are made

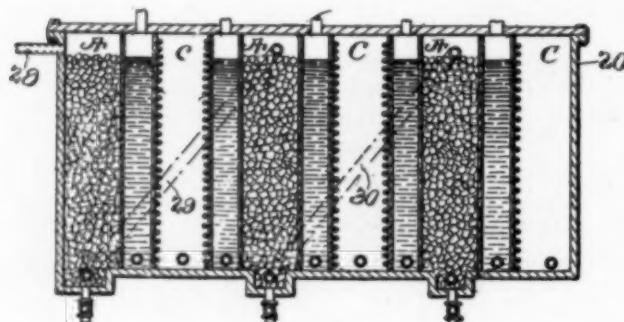


FIG. 1

narrow especially to diminish energy losses in overcoming the resistance. Furthermore, the polarization effect of the chlorine collecting on the anode is continuously neutralized by leading purified oil gas successively through the anode chambers by pipes 28, 29, 30 and 31. The olefins on contact with chlorine may react in either of two ways. One is a direct combination with it to form olefin chlorides, ethylene, C_2H_4 , thus gives ethylene chloride, or "Dutch liquid," ($C_2H_4Cl_2$) a heavy oily body insoluble in water and having an odor and many other properties resembling those of chloroform. The other reaction is one in which water takes part and a chlorhydrin, or chlorinated alcohol, is produced. A molecule of chlorine, Cl_2 , reacts with H_2O and C_2H_4 to produce HCl and C_2H_4OHCl , or a chlorhydrin. The actual reactions at the anode vary with conditions; with a high current density chlorine may form as a gas. With an ample amount of water vapor chlorhydrins are formed. The recovery and separation of the separate products also depends upon the degree of formation and the use to which the product is to be put. (Assigned to Chemical Development Co., 1,264,536; Apr. 30, 1918.)

Process of Making Exchange Bodies.—GEORGE RUDOLF of London, Eng., notes that many natural silicates contain more or less zeolite which is a very active "exchange body." These minerals are very

useful in purifying water; an exchange takes place between the calcium and magnesium compounds of the water and the alkali of the silicate, the latter going into solution as harmless alkali compounds while lime and magnesia remain in the zeolite. After a sufficient period of use the exchange silicate is revivified by treatment with a solution of common salt ($NaCl$); sodium now enters the silicate, while calcium and magnesium are given up to the salt solution as chlorides. The inventor finds that if these igneous rocks (such as trass) be pulverized and boiled with 10 per cent hydrochloric acid, a certain portion of these complex exchange silicates goes into solution. After filtering and washing, the residue is boiled for several hours in a ten per cent solution of alkaline carbonate, to which a small amount of caustic soda has been added. This extract is then mixed with the acid solution, the gelatinous precipitate filter-pressed, and the cake dried at about 70 deg. C. On throwing this cake into water it breaks up into hard, angular grains, which after centrifuging, are found to contain the "exchange" properties of the original trass in a very marked degree. (Assigned to the Permutit Co., 1,263,706; Apr. 23, 1918.) Lemberg pointed out in 1876 that gelatinous exchange bodies could be produced from solutions of alkaline aluminates and alkaline silicates. Previous attempts to convert this gelatinous mass into clinker-like, strong and pervious substances have failed because the precipitate always contained a considerable excess quantity of alkaline mother liquor. The present inventor finds that it is only necessary to mix two solutions of two hydroxides of more or less amphoteric properties together, one such solution being alkaline in reaction and the other being neutral or acid. The word neutral means containing an amount of acid component chemically equivalent to the metal functioning as a base, such, for instance, as aluminium sulphate. As a particular case, if a solution of aluminium sulphate is mixed with a solution of commercial water glass in such proportions that the final mixture shall be neutral to phenolphthalein, a precipitate appears. If this precipitate is filter pressed, dried and granulated as above, it will be found to have "exchange" properties. (Assigned to Permutit Co., 1,263,707; Apr. 23, 1918.)

Apparatus for Manufacturing Chlormethane.—Patents No. 1,111,842 and 1,190,659 cover the method of mixing chlorine with a large excess of methane in the cold and then passing the mixture into a heated reaction vessel. Two objects are then attained, namely, a smooth reaction free from carbonization, and a product which consists chiefly of monochlormethane. The chlorination vessel if made of silica or brick is hard to make tight, while on the other hand, most metals are attacked by hot chlorine or catalyze the reaction

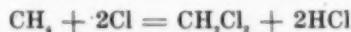


The inventor has therefore devised a furnace shown in Fig. 2 consisting essentially of a tight iron tank 1 lined with silica brick 2, with a packing of powdered flint 3 between the two. The cold chlorine entering through pipe 16 is mixed with about five times its volume of cold methane coming through valve 20 in the tee 15. Ten volumes of methane are heated in furnace 17 to about 370 deg. C., and the two gas

streams unite in the silica tube 9 and enter the reaction chamber at a temperature of about 250 deg. C. The reaction



together with a small amount of the reaction



goes forward smoothly without the production of carbon and hydrochloric acid until the gases issuing through 22 contain less than 0.01 per cent of uncombined chlorine. The temperature of the chamber is maintained by the heat evolved by the chemical reaction itself to a temperature of from 400 to 500

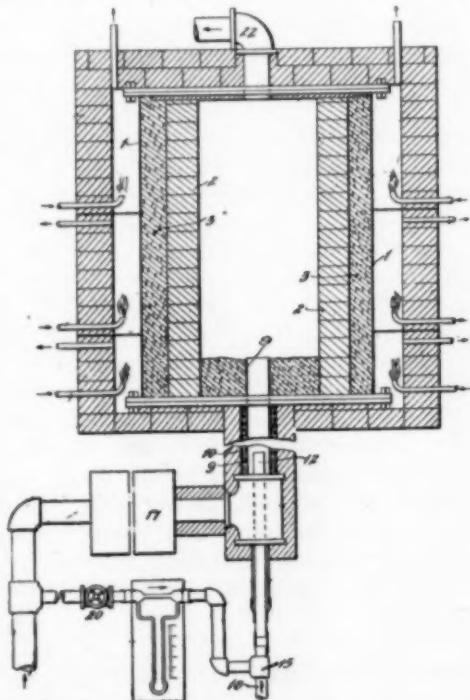


FIG. 2

deg. C., and it is only necessary to heat the external iron shell 1 sufficiently that excessive radiation may not cool the contents. Any chlorine gas which percolates outward is changed to hydrochloric acid by contact with the powdered flint before reaching the shell, and consequently rendered incapable of corroding the steel. If pure chlorine enters hot methane as through pipe 12 a chlorine flame produces carbon black and hydrochloric acid only. Dilution as above noted is necessary and the temperature control is very easily had by merely regulating the amount of methane bypassing the furnace 17. (Assigned to Roessler & Hasslacher Chemical Co., 1,263,906; Apr. 23, 1918.)

Side Blown Converter Process.—JOHN H. HALL, of New York City, (assigned to Taylor-Wharton Iron and Steel Co.), notes that in blowing metal containing say 2 per cent silicon and 0.5 per cent manganese in a side blown converter, the blast impinging on the surface layers will oxidize the various impurities in what amounts to a thin layer of metal. The silicon and manganese oxides form a slag which absorbs iron oxide until the slag becomes freely fluid, and at the same time the iron oxide contained makes it highly oxidizing. This fluid slag is stirred into the carburized

metal remaining in the lower part of the bath by the air currents, when a violent reaction liberating large quantities of carbon monoxide causes a boiling action to froth the metal and slag up so as to overflow the mouth. After subsidence, the slag is stiff and low in iron oxide, and the cycle starts again. In case the manganese is contained in the metal in a greater relative percentage, the time between boils is correspondingly diminished. The patentee claims the process of making slags as high in manganese (approximately of a composition SiO_2 40% and MnO 60%) that it produces a freely fluid slag from the first and during the greater part of the operation. This slag does not absorb iron oxide as does another lower in manganese, and any iron oxide formed by the blast is then immediately available as an oxygen carrier to the metalloids, which are thereby eliminated gradually without frothing. The requisite proportions of silicon and manganese are had by melting proper pig irons, scrap steels and ferroalloys in the cupola. (1,249,075; Dec. 4, 1917.)

Acetyl Cellulose.—WM. G. LINDSAY, of Newark, N. J., received a patent for a method of producing acetylation of cellulose in varied degrees, in which cellulose fibers are saturated with acetic acid and alcohol, then subjected to dehydrating agents—acetic anhydrid, sulphuric acid, benzine, etc—the resulting fibers being physically unaltered and soluble in acetylene tetrachloride. (1,265,216; May 7, 1918.)

Alunite from Potash Recovery.—HOWARD F. CHAPPELL, of New York, N. Y., patents the method of converting the alkali in insoluble alumina of calcined alunite into water-soluble compounds, which comprises washing and filtering the calcined alunite to remove soluble potassium compounds, mixing the filter cake with an alkali and an alkali earth, calcining the mixture at about 900 deg. C., and leaching the water-soluble compounds from the calcine. (1,270,266. June 25, '18.)

Bauxite.—WALTER L. MELICK, of Columbus, Ohio, patents the process of heating to its boiling point a mixture of substantially saturated aqueous solution of sodium hydroxide and bauxite ground to a degree of fineness of at least seventy mesh, the mixture having the consistency of a thick paste, adding water frequently to prevent drying out, and finally leaching the sodium aluminate formed (1,271,192. July 2, 1918).

Rust Prevention.—WM. H. ALLEN, of Detroit, Mich., notes that when articles of iron or steel are treated with soluble acid phosphates according to the patents to Coslett, No. 870,937, and to Richards, No. 1,069,903, they sometimes rust in very small spots. This is possibly due to the formation of hydrates or other compounds capable of causing rusting. He patents the process of rendering these undesirable compounds of iron inactive by placing the treated article for a short time in an approximately five per cent solution of alkali ferrocyanide. By this treatment the deleterious iron compounds are probably changed to mixtures of ferri and ferrocyanides, which are non-corrodible. (1,260,740; Mar. 26, 1918.)

Purifying Iron in a Blast Furnace.—GUSTAV R. GEHRANDT, of Oak Park, Ill., patents the process of

purifying the iron produced in a blast furnace by installing a lower row of tuyeres inclined downwardly and so placed that they deliver a stream of hot air into the metal bath, as shown in Fig. 3. The inventor claims that in this way a purified iron is produced; at the same time a saving in fuel is effected owing to the heat abstracted from the molten metal and that fur-

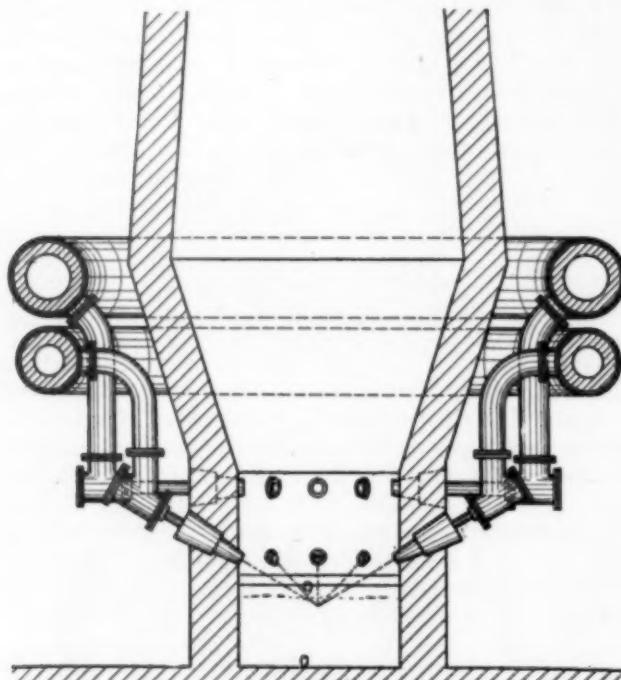


FIG. 3

nished by the purification reactions. The principal agitation is confined to the center of the hearth, leaving a comparatively placid annulus near the walls from which the slag can be drawn without interrupting the refining process. (1,260,660; Mar. 26, 1918.)

Sponge Iron.—ALF SINDING-LARSEN, of Norway, patents a process of manufacturing iron sponge from ore wherein the ore is spread in a thin layer over a perforated plate. Heat from an electric resistor is radiated from above through an atmosphere of hydrogen-carrying gas. The water vapor formed by the reaction diffuses quickly, by reason of a great difference in partial pressure, through the ore bed and perforated plate into a lower channel where it is condensed on cooling pipes. In this manner the reduction is more complete, since reoxidation of the iron by moisture is prevented. The ore bed may be carried on a car, whose reciprocating motion works the charge forward with the aid of rabbles fixed in the furnace roof. (1,256,939; Feb. 19, 1918.)

Annealing Atmosphere.—FRANK PERRY, of Tipton, England, notes the fact that producer gas used as an atmosphere to prevent scaling or filmlike deposits on metal surfaces during annealing is usually treated in some manner to remove the contained water vapor, unsaturated hydrocarbons, and sulphur compounds. This is not sufficient to prevent all action on bright surfaces, in which case he patents the method of removing saturated hydrocarbons (methane, etc.) by passing the cleaned gas through a tube at 250 deg. C.

containing loose pieces of iron, renewed periodically. (1,261,606; April 2, 1918.)

REFRACTORIES

HARRY A. KENNEDY of Clearfield, Pa., proposes to increase the refractivity of silica bricks by carefully screening out and discarding all fine particles of silica before mixing with the finely ground binder of fire clay. In this manner the formation of somewhat fusible silicates between the finely divided and mixed particles of clay and silica is prevented. Bricks subjected to no abrasion can be made of large-sized silica with a minimum amount of binder, while in other cases the expansion of the silica may balance the shrinkage of the clay so as to form a brick of approximately zero temperature coefficient. (1,260,398; Mar. 26, 1918.)

PAUL R. HERSHMAN, of Chicago, has previously patented (No. 1,135,182) the production of refractories capable of withstanding a temperature in excess of 2200 deg. C. These he formed by the use of alumina (preferably from calcined alunite) bonded with carbonaceous material such as glue, hard pitch, and glue-like "tank water" from abattoirs. In heating these pressed refractories he found that they tended to disintegrate during the temperature interval above the decomposition point of the carbonaceous material and below the sintering temperature of the aggregate. He therefore patents the use of a binder such as calcium sulphite which will form compounds holding the mass coherent during this interval, but on further intense heating will be volatilized and thus have no effect upon the ultimate refractivity of the brick. (1,240,569; Assigned to Mineral Products Co., Sept. 18, 1917.)

Manufacture of Spiegel.—A. L. CROMLISH, of Sharon, Pa., patents the process of smelting "flush" or "tapping" cinder produced in the open hearth process into a low-manganese, high-phosphorus spiegel which can then be used as a ladle or furnace addition when making steel for subsequent rolling into thin sheets, which steel, as is known, requires a slight addition of phosphorus to prevent sticking when rolling packs of fours and eights in the finishing passes. (1,261,907; Apr. 9, 1918.)

Ferro Phosphorus.—H. A. WEBSTER, of Columbia, Tenn., finds that if a proper mixture of iron phosphate, coke and limestone is heated to from 1000 to 1500 deg. C. in a rotary kiln, the interior of the furnace becomes lined with incandescent carbon, which materially hastens the reaction. The products of the reaction—an iron phosphide containing 22 to 25 per cent phosphorus, and a slag—may be granulated and separated by a magnetic separator. The gasified phosphorus may be largely retained in the modular phosphide by charging iron filings or iron ore with the mixture. (1,264,237; April 30, 1918). The proportion of phosphorus in the compound may be increased to 28 or 30 per cent by heating the above mixture in a closed furnace at two to three atmospheres, cooling the melt under pressure until just molten, and then tapping the contents. (1,264,236; April 30, 1918.)

Northrup-Ajax High-Frequency Induction Furnace

THE induction furnace described herewith presents features in furnace practice which are radically new in every particular.

All types of induction furnaces heretofore made consist essentially of a step-down transformer. The primary winding of this transformer has many turns on an iron core, and is designed for direct connection to a source of alternating current supply of ordinary or very low frequency. The secondary of this transformer is a closed loop of one turn. The heat developed by the large current which circulates in this single turn is the heat which is utilized. This single turn, usually of molten metal in a trough of refractory material, constitutes a closed electric circuit through which the iron core of the transformer threads.

By employing current of high frequency it becomes unnecessary to use any iron, interlinking with the primary winding and the secondary electric circuit, to obtain the powerful inductive effects which are required to produce efficient heating.

unnecessary to use any iron, interlinking with the primary winding and the secondary electric circuit, to obtain the powerful inductive effects which are required to produce efficient heating. The frequency found desirable to use for obtaining good efficiency in the heating is about 20,000 cycles per second. The successful operation of the Northrup-Ajax high-frequency induction furnace is not dependent upon any particular source of supply of this necessary high-frequency current. It has been found most convenient and satisfactory in the construction of furnaces under 100 kw. capacity to use as a source of high frequency current the oscillatory discharge of a bank of condensers.

FIG. 1

By properly proportioning the capacity and inductances of the oscillatory current circuits the desired frequency is obtained.

While this type of furnace is perfectly adapted to operation on polyphase circuits with balanced load on the different phases, the particular furnace here described is constructed to operate on single phase only or on one phase of a polyphase supply. The electrical circuits employed for single phase operation appear in Fig. 1.

The line current may be supplied at 110, 220, or 440 volts and 60 cycles. A transformer Tr steps this e.m.f. up to about 8000 volts. A bank of condensers C is charged at this voltage and upon rupture of the gap G oscillations occur.

The current with free high-frequency oscillations passes through an "inductor" coil F which surrounds the crucible or mass M to be heated.

This inductor coil has from 50 to 80 turns only and yet its inductive effect is so powerful that currents of great magnitude are induced in the crucible walls, if this is conducting, or in the mass of conducting ma-

terial held in the crucible, if the crucible is non-conducting. The mass M heats with great rapidity, the inductor coil itself remaining practically cool. A small quantity only of heat-insulating material surrounding

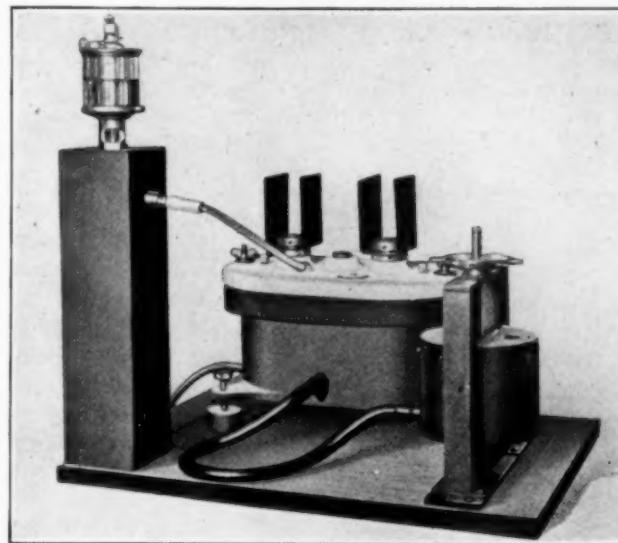


FIG. 2—DISCHARGE GAP

the crucible is required to retain the heat developed. As this heat is developed within the mass to be heated and is not absorbed from an outside supply of heat, as in the resistance wound furnace, it is possible to obtain very high temperatures. No material other than the crucible and its contents is subjected to a destructive temperature, and consequently this type of furnace never burns out and so becomes inoperative.

A series reactance X_e with tap-offs permits perfect regulation of the power consumed, and another reactance X_s connected in shunt to the line on the primary side of the transformer serves to adjust the power-factor of the line to be practically unity. If power is supplied from a source of lagging current, X_s can be so chosen as to improve the power factor.

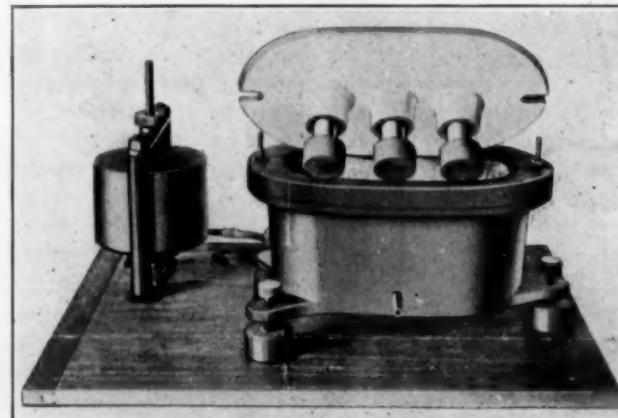


FIG. 3—INTERIOR VIEW OF DISCHARGE GAP

The power which the furnace will absorb from the source of supply is exactly proportional to the number of condenser units used in the bank of condensers which go to make up the capacity C . Calculation and experiments show that for the size of unit adopted, which is in over all dimensions 12 x 16 x 13 in. and in capacity 0.07 m.f., 1.5 kw. per unit can easily be obtained. Thus a

bank of 16 condenser units is required for a 20 kw. furnace outfit. Of the power supplied at the main switch terminals not less than 50 to 60 per cent makes its appearance as heat in the crucible and contents, being heated by induction.

The discharge gap is also of a radically new type. It has no moving parts and consists essentially of two graphite electrodes (three for two-phase or three-phase operation) opposed to a level surface of mercury. The mercury is contained in a cast-iron pot. The level of the mercury is made adjustable by means provided for lowering and raising an outside reservoir of mercury. The electrodes with graphite tips project through the tightly closed cover. As the discharge takes place in a tightly closed chamber, the noise from the discharge is slight and not at all objectionable. This gap is found to operate better and the surface of the mercury remains clean if alcohol is slowly dropped into the chamber at about 15 drops a minute.

In Fig. 2 is shown a reproduction of a photograph of a mercury discharge gap with alcohol dropper and mercury regulator. In Fig. 3 is shown a gap with its cover raised to expose to view the electrodes (only two of which are used in single phase operation).

In Fig. 4 is shown a photographic reproduction of a 20-kw. oscillatory current system. It consists of a bank of 16 condenser units and a discharge gap.

Fig. 5 is a photographic reproduction of an oscillatory current furnace of the vacuum type. The practical results obtainable with this new type of induction furnace are numerous and important:

(a) Temperatures exceeding 1600 deg. C. are readily obtained.

(b) Most all nonferrous metals are readily fused without contamination of any kind. The fusion can be made in air or in any desired atmosphere or in vacuum.

(c) Pure iron and pure nickel are readily fused free from contact with carbon.

(d) A nonconductor, as enamel or a high melting glass, is readily fused. Porcelain samples and clays can be studied at temperatures used in firing.

(e) A bath of molten tin, lead or any salt may be uniformly heated and the temperature controlled so that it may be used for heating steel for hardening.

(f) The furnace can be varied in size and form to adapt it to any special requirements. It may be of horizontal, of vertical cylindrical type, or of the muffle type.

(g) A uniform high temperature, up to 1600 deg. C. or more, with a 16-condenser unit outfit, may be main-

tained throughout the volume of a cylinder 6 in. in diameter and 12 in. long, for any kind of heat treatment, such as the heating of iron or steel to be forged. This temperature may be obtained in less than 40 minutes starting cold.

(h) The furnace is admirably adapted to the making of almost all kinds of alloys. The separate constituents can all be heated up from the cold and the alloy allowed to solidify without cracking the container, and if desired may again be heated to fusion without injuring the container. This furnace was invented and developed by Dr. E. F. Northrup for the Ajax Metal Company of Philadelphia. It is manufactured and sold by the Pyroelectric Instrument Co., Trenton, New Jersey. An illustrated 20-page circular describing this furnace has been recently prepared for distribution.

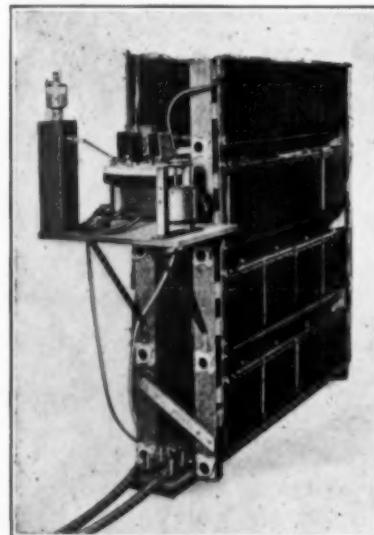


FIG. 4.—OSCILLATORY CURRENT SYSTEM ASSEMBLY

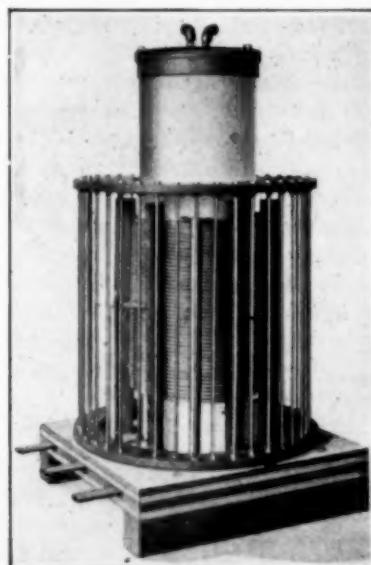


FIG. 5.—STANDARD VACUUM TYPE OF FURNACE

Hydraulic Operation of Furnace Doors

THE operation of heavy doors, such as are used on open-hearth and heating furnace work, is usually accomplished by the use of hydraulic systems, consisting of pumps, pressure tanks, high pressure pipes, three-way valve, etc. On account of the fact that doors must go up when wanted to go, and vice versa, and due also to the fact that water under pressure has been reliable in the past, the hydraulic system has almost universally been adopted. This is also proof of the fact that no fool-proof, absolutely dependable electric control has ever been worked out before for open-hearth work. A few electric attachments have been made, but they resulted in failure.

The Alan Wood Iron & Steel Co., Conshohocken, Pa., have had in use for thirteen or fourteen months, five hoists with an automatic release, invented by one of their men and manufactured by the Link-Belt Company. These hoists have been in continuous and regular operation without any repairs, attention, or maintenance expense whatever. The illustration shows each hoist provided with a pair of chain sheaves, mounted loose on a worm wheel shaft, between two flanges which are pinned to the shaft and supplied with fiber friction surfaces on the sides toward the sheaves. The worm wheel is driven by a worm mounted on the shaft of a reversible motor, the worm and wheel being enclosed in suitable housing.

To the left-hand sheave is attached a chain which leads up to the tackle for raising the furnace door, and to the right-hand sheave is fastened a chain from which

is suspended a heavy counterweight (down behind the mechanism shown). The wrap of the chains around the sheaves is in opposite directions. The contact surfaces between the sheaves have a beveled, or spiral shape, with the result that when both chains are under tension, the sheaves are squeezed tightly against the friction flanges at the sides, and thus compelled to rotate in the direction of motion of the worm wheel shaft.

To raise the furnace door, the motor is started in the direction which will pull down on the left-hand chain. As long as the counterweight continues its pull, the sheaves squeeze out against the flanges, and are thereby driven in the direction which will wind up the left-hand chain, and thus lift the door. The right-hand sheave has a fixed stop on its periphery, so located that it will come in contact with a stop on the bottom casting when the furnace door has reached its proper height. With the motion of the right-hand sheave arrested by this stop, the shaft cannot rotate the left-hand sheave further, because the squeeze between the sheaves and friction flanges is relieved. There is no opportunity, therefore, for over-winding, and if through carelessness

which have proved so troublesome for this type of hoist, as well as for skip hoists; and it secures an exact stop for all such hoists, without involving failure from human carelessness or complicated electrical equipment. The motor is started, stopped or reversed by simple push-button mechanism.

In the case of skip hoists, the sheaves of course, would be replaced by drums. Doubtless various other applications of the device will suggest themselves; and the fact that it is entirely fool-proof will be appreciated as a great advantage.

Developments in Grading Solids

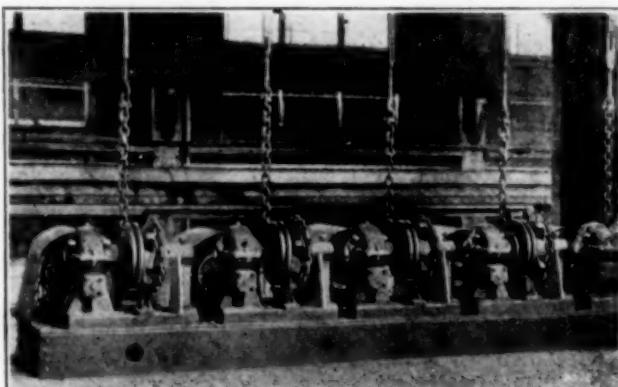
STARTING with information drawn from hand sieving, engineers developed an enlargement of this apparatus and called it a shaking screen. All sorts of mechanical motions were applied—eccentrics, toggles and rotators—all being highly successful except for the clogging of the finer meshes. Screen cylinders were developed and somewhat improved by hexagon and octagon forms, but still the milled material tended to accumulate and clog the wires.

Finally the inclined screen with tightly strung wires to which vibrating knockers were applied was evolved. Several advantages were to be had in this form of appliance. Several sizes can be graded at one time; the operation is continuous and regular; the coarser meshed screens, being on top, protect the finer and more delicate ones beneath. The size of the product varies with the cosine of the angles of the incline—200 mesh material is obtained on a 100 mesh weave when the slope is 60 degrees—so that heavier screens can be used for any given work. This gives greater wearing properties besides permitting greater vibrations. Moreover, clogging never takes place.

Of this type of appliance, the new Super Newaygo, manufactured by the Sturtevant Mill Co., Harrison Square, Boston, Mass., is very substantially built and designed for unit construction so any capacity desired can be assembled. All the parts are instantly accessible and can be quickly repaired by replacements when necessary. The coarse screen acts as a scalper and is located in the cover, which is so counterweighted that it can be raised with one hand, leaving the finer screen fabrics accessible. Very efficient knockers apply sufficient vibration to keep the mesh wires clear.

Licensing of Engineers

At the regular meeting of Engineering Council June 20, a special report by the Public Affairs Committee on the Licensing of Engineers, was debated at length. It was decided to create a small Special Committee, with very carefully selected membership, to study this important question thoroughly with a country-wide view. It is intended that through the work of this committee, Engineering Council shall in due time be prepared to advise engineering organizations in any of the states upon this much discussed matter. Engineers who have knowledge of proposed legislation are requested to communicate with the Secretary of Engineering Council. Information or rumor has already been received of possible action by the Legislatures of Iowa, Ohio, Indiana and Michigan. As is well known, a few states have passed laws.



THE LEWIS HYDRAULIC HOIST

the current is not shut off promptly, the shaft with its flanges will simply continue to revolve in sliding frictional contact with the sheaves, but without power to grip and rotate them further.

For lowering the doors, the direction of the motor is reversed, and practically the same process repeated, except that in this case the power of the motor is used to lift the counterweight, while the pull from the weight of the door serves to keep the sheaves squeezed apart against the friction flanges, until a stop on the left-hand sheave engages with a stop on the bottom casting, and prevents over-winding of the counterweight chain in the same manner as described for the other sheave. In other words, the door always goes up to the proper position, and always comes down to the proper position, no matter what its weight may be. Even if the door were considerably heavier than the counterweight, there would be no danger of its descending and pulling the counterweight up when the motor is stopped, for the instant the counterweight sheave is started toward reversal, the pull of its chain would squeeze the sheaves apart against the friction flanges, and the two sheaves would thus be put completely under control of the worm wheel shaft again, and the worm wheel is, of course, locked in position by the worm. The stop feature does away with the automatic electric switch devices

Book Reviews

THE HISTORY OF CHEMISTRY, by Prof. T. S. Moore.
240 pages. Price, \$2.50. New York: McGraw-Hill Book Co., Inc.

According to Dr. George Sarton, erstwhile of the University of Ghent, the history of science is the history of man's conquest over nature. In this respect only has man been constantly progressive. In religion, in morals, and in arts, the question of his steady advancement is open to discussion, whereas in science his advancement has been slow but continuous. Therefore, if we would know man as a progressive creature, we must consider him from the angle of vision in which this quality comes into view. If we would make a just estimate of the present from the past and would compute the future in the light of human advancement, we shall need the history of science to enlighten us. The history of science is therefore of value from an ethical standpoint.

And now Professor Moore has given us a textbook on the subject of chemistry. From beginning to end the pinch of space is felt, because the subject is one for a whole library rather than for a single book, and with such wealth of material it was necessary to compress and delete and squeeze until only the high lights are touched upon. And these high lights, like John Mayow, come out of the shadow of the past and fit by so swiftly that the little glimpses we get seem all too short and inadequate. But we are dealing with a textbook on the history of chemistry and it is the business of a textbook to whet the appetite.

Dr. Moore addressed himself to a history of the science rather than a record of the men who made it, and this gives us an excellent short memorandum of its development. Only six pages cover the history of the Greek contributions and but eight pages are devoted to alchemy; then we begin with the Renaissance, with Paracelsus the first chemist.

But even here there are only seven pages to lead us along through the iatro-chemists, from Phillipus Aureolus Paracelsus Theophrastus Boumbastus Eremit von Hohenheim, born in 1493, to and including Johann Rudolf Glauber (1604-1668) who sold secret medicinal preparations, including the salt that bears his name. These notes include a memorandum on Agricola who, although a physician, was rather a metallurgist than an iatro-chemist, as is duly pointed out.

At this point we reach a rebirth in chemical philosophy, beginning with Robert Boyle (1627-1691). From the time of the Greeks until Boyle's day, it would seem that whatever there was to chemistry had been kept outside of the pale of distinguished scholarship. The alchemists worked in secret and their ideals were not such as to attract men of character. Albertus Magnus and Roger Bacon seem to have been men of vision, although the usual alchemistic purpose was to get rich quick by a clever trick. To devote a life to finding how this may be done has never appealed to the best quality of men.

Robert Boyle was a gentleman by birth, training, education and character, and his advent gave the signal for high thinking, open-mindedness and frankness. By the very merit of his work he put the quack doctors where they belonged without the trouble of quarreling with them. He did it very simply—by outclassing them. When we look up we look for the top and when men of his day looked toward the top in chemistry they found a gentleman and a scholar instead of an itinerant quack doctor with secrets to sell. Then chemistry began to grow and, in spite of Stahl's unfortunate injection of phlogiston into the subject, Boyle had set the pace.

Dr. Moore gives a photograph of a page of Stahl's "Fundamenta Chemiae," which was begun in Latin but finished in German. The page in question is from the middle of the book and we shall give only part of a sentence to show his style. It is no wonder that a man who wrote like this should confuse chemistry! "Denn es gehen in dieser Dissolution des nitri, idem sich die Mixtur entzuendet, variae portiones in forma flammae weg, und machen einen

Rauch welche eine kuenstlich, applicato scil. super crucibulum recipitum recipiente fangen; nemlich sie thun diese Mixtur in ein gluehend Geschirr . . . und der Dunst . . . wird gefangen, da er sich in einen Liquorem condensirt, qui vero plane alienus est a Spiritu nitri indole. . . ."

The book proceeds rapidly over the thorny road of phlogiston, giving, in carefully arranged sequence, what was thought by men who have made leading contributions to chemistry on the subject in hand. The problem of the author required that this be done and limitations of space doubtless required that only the merest reference be made to the personality of most of these men. This is the criticism we have to make and we do so without blaming the author or the publishers. A textbook must be compact. It is richly illustrated, chiefly by means of portraits of great men, but we would prefer their biographies to their likenesses.

There are two methods of teaching history. One is the method selected by the author to give a history of the subject and to mention the leaders as incidents in its development. This is the short and compact method. The other is to provide a more general record of progress and then to confirm the steps by giving biographical sketches of the leaders, including such personal details concerning them as will confirm them in memory. This takes more time and is less orderly, but it has its advantages. It humanizes the subject and that makes it more likely to be remembered. There is in this book a delightful little sketch of John Dalton written by himself which shows him as a school teacher at twelve years of age, and there is also a living and sincerely appreciative picture of Liebig, which is very charitable without. Of Berzelius we should like to know more, although he is recorded as the organizer of the science. It is, on the whole, a scholarly work and, so far as we have been able to observe, it is unusually free from error.

Personal

MR. PHILIP R. BRADLEY, of Treadwell, has been appointed Food Administrator for Alaska.

MR. HENRY CASE, until recently director of technical research with the David-Bournonville Co., Jersey City, N. J., has assumed the duties of production manager of the S. K. F. Ball Bearing Co., Hartford, Conn.

MR. L. G. EAKINS, for years general manager of the Colorado branch of the American Smelting and Refining Company, has resigned his post in Denver and will move to New York City as consulting metallurgist for the smelting corporation. He will be succeeded in Denver by C. A. H. DeSaules, who has held an important place with the company in New York City. In New York Mr. Eakins will be located at 120 Broadway.

MR. JAMES H. HUGHES has been appointed manager of the steel and tube department of the Timken Roller Bearing Company at Canton, Ohio, effective July 1. He was formerly with the Carnegie Steel Company, having spent fourteen years in that organization.

MR. J. W. HUTCHINSON, former manager of Goldfield Consolidated Mines Co., has resigned to join the Army. He is succeeded by E. A. Julian, former chief engineer of the Wingfield interests.

MR. G. J. KAPTEYN, a Dutch engineer widely known and traveled in metallurgical and mining districts in both Americas, has passed through the United States en route to the East Indies on Dutch government business.

MR. A. D. LEDOUX has been appointed chairman of the Chemical Alliance Committee on the Production, Distribution and Control of Sulphur Materials. His associates are W. D. Huntington and C. G. Wilson. Headquarters are at Room 135, Interior Building, Washington, D. C., or 15 William St., New York City.

MR. H. J. MORGAN, of the General Chemical Company, has been transferred from the Delaware Works at Marcus

Hook, Pa., to the main laboratories of the company at Laurel Hill, Long Island, where he will be chemist in charge.

PROF. C. W. PARMELEE, of the department of ceramic engineering, University of Illinois, Urbana, Ill., is making a survey of the ball-clay deposits of West Tennessee.

MR. JOEL H. WATKINS, formerly economic geologist for the Southern Railway System, has opened an office at Room 1364, 200 Fifth Avenue, New York. He intends to devote special attention to the mineral resources of the Appalachian South.

DR. THEODORE W. RICHARDS, Erving professor of chemistry and director of the Wolcott Gibbs Memorial Laboratory at Harvard University, has been made a foreign member of the Accademia dei Lincei, Rome. He has been elected an honorary member of the Royal Irish Academy.

MR. H. E. SHIVER, assistant chemist, South Carolina Experiment Station, Clemson College, S. C., and formerly a member of the United States Army Flying Corps at Princeton University, has accepted a position as chemical engineer with the Air Nitrates Corporation at their electrochemical plant at Muscle Shoals, Ala. He will be in a supervisory position in unit 5 of the plant.

MR. ARTHUR H. YOUNG, director of the American Museum of Safety since January 1, 1917, has resigned to take charge of the Employee Relations Department of the International Harvester Company. He will take up his new duties immediately but will continue to be closely concerned with museum affairs, as he has been elected to the vice presidency, succeeding the late Dr. Frederic R. Hutton.

Obituary

PROFESSOR STEPHEN FARNUM PECKHAM, chemist and authority on bitumens, died at his residence at Brooklyn on July 11, at the age of seventy-nine. Professor Peckham was born at Fruit Hill, Providence, R. I., and was educated at the Friends School and at Brown University. From 1869 to 1873 he taught chemistry at Washington College. Later he held the chair of chemistry at Maine State College and at the University of Minnesota. He was also chemist to the Minnesota Geological Survey and the State Board of Health.

From 1898 to 1911, he conducted a laboratory for the Commissioners of Accounts and later for the Finance Department of New York. He contributed scientific articles to the *Encyclopedia Britannica*, the *American Encyclopedia* and *Chemical News*, and wrote a treatise on asphalts. Nine years ago, he suffered a stroke of paralysis, which ultimately caused his death. His wife, two daughters and a son survive him.

Current Market Reports

Non-Ferrous Metal Market

Thursday, July 25.—With strong demand and higher labor costs, prices still tend to increase except where fixed by regulations.

Aluminium:—The government price on ingots is 33c. a pound f.o.b. plant in 50-ton lots, 33.1c. down to 15-ton lots, and 23.2c. in lots down to 1 ton, and 40 to 45c. for smaller lots; sheet aluminium, 18 ga. and heavier, 42c.; and powdered aluminium, \$0.65 to \$3.00 per lb. according to mesh.

Antimony:—The demand is developing and spot duty paid has advanced to 13½ to 13¾c.

Chrome:—Producers have established a schedule on the basis of \$1.30 per unit ore; some 40% ore has been sold at a premium at \$1.50 per unit.

Copper:—Government price fixed at 26c. until August 15. Copper products are quoted at:

Copper sheets, hot rolled.....	\$0.36 — \$0.37
Copper sheets, cold rolled.....	.37 — .38
Copper bottoms.....	.44 — .45
Copper rods.....	.36 — .37

Copper wire.....	.29½
High brass wire.....	.28½
High brass sheets.....	.28½
High brass rods.....	.26½
Low brass wire.....	.32½
Low brass sheets.....	.32½
Low brass rods.....	.34½
Brazed brass tubing.....	.37
Brazed bronze tubing.....	.42½
Seamless copper tubing.....	.41
Seamless bronze tubing.....	.45
Seamless brass tubing.....	.37½
Bronze (gold) powder.....	1.00 — 1.75

Lead:—Metal scarce for spot delivery. Price in New York 8.05c. per lb., in East St. Louis 7.75c. in 60,000-lb. lots; full lead sheets, 10c., cut sheets 10½c.

Manganese:—Such lots of manganese ore as reach New York are quickly taken at \$1.35 basis.

Molybdenum:—Quoted at \$1.25 per pound MoS₃ for 90 per cent material. There is considerable inquiry from abroad, but it is not known whether exportation will be permitted.

Spelter:—Bids are at 8.6c., while 8.75c. is asked. East St. Louis settling price is 8.40c. in 60,000-lb. car lots. Sheet zinc is 15c. and zinc dust 18 to 20c. per pound.

Tin:—Imports for the first three weeks of this month have been 5000 tons. Banca tin spot delivery for Government work has brought \$1.00 per pound, futures at 90 to 95c. Chinese tin for August shipment is quoted around 91c. Babbitt metal varies between \$1.10 and 70c. per pound. Solder 50-50, 73c.

Tungsten:—The highest grade material containing no tin, no copper and low manganese and over 70 per cent WO₃ is very scarce. Ore with slight impurities is bringing \$23.50 per unit, lowest grades down to \$18 per unit.

OTHER METALS

Bismuth.....	lb. \$3.50
Cadmium.....	lb. 1.50
Cobalt.....	lb. 2.50 — \$3.50
Magnesium.....	lb. 1.75 — 2.00
Mercury.....	75 lb. 125.00 — 130.00
Nickel.....	lb. 40.00 — 45.00
Iridium.....	oz. 175.00
Palladium.....	oz. 135.00
Platinum.....	oz. 105.00
Silver.....	oz. .99½

The Iron and Steel Market

While much of the discussion relating to supplies and requirements in steel relates to the demand that is not accorded any form of precedence by the controlling authorities and to the supplies that may be left for such purposes after the preferences, etc., are met, the fact is that by far the most important matter in steel distribution is the distribution under the priorities and preferences. Steel producers quite familiar with the situation continue to estimate that the demand accorded no form of precedence does not amount to 10 per cent of the total demand, and thus it is relatively unimportant when the 90 per cent or more is very far from being fully taken care of.

The trade has become familiar with the new nomenclature and regulations prescribed by the War Industries Board's statement dated July 3 and subsequently circulated to the trade. The sequence in which wants are to be taken care of is as follows: Priorities, AA, A and B, respectively, with certain subnumbers; Preferences, or Class C; Class D, or all other.

The priorities are precise orders, requiring a producer to furnish a consumer a specified quantity of material. It is not necessary that all priority orders be actually filled before any material is shipped under preferences, but merely that they shall be "provided for," i.e., the producer must be assured that the manufacturing facilities are set aside to the extent necessary to make the shipment in good time.

The preference list, while given as an appendix in the statement of July 3, is substantially the list originally promulgated under date of June 6. It prescribes the sequence of importance, and runs from direct war purposes through to peace or commercial purposes of the more important character, the purposes being in brief: Ships, aircraft, munitions, fuel, food, clothing, railroad, public utilities. All these classes, it is now clearly understood, are to be interpreted broadly. Food, for instance, covers everything in the production and preparation of food, even to the

production of cook-stoves and cooking utensils for the household, though there is an order of sequence here also, and the public is expected to get along with as few new cook-stoves as possible. The mills are expected to use their judgment in these matters, referring doubtful cases to Washington.

The Class D material is subject to production and shipment only by written permit of the Director of Steel Supply, except that shipments up to five tons are covered by a blanket permit, subject to the restriction that the producer must report all such shipments monthly and certify a belief that they were "in the public interest."

The jobbers are placed under the same restrictions as the producers in the matter of making shipments. They are required to report shipments and are to be given replacement of material against approved shipments. They are, however, required to endeavor to get along with as light stocks as possible and are expected to influence retail dealers to do the same.

NOT ENOUGH STEEL

With the amount of priority business on books and the government's demand for material under the preference list, there is far from enough steel to reach fully over the commercial purposes that are covered by the preference list. There is a divergence of opinion whether the more direct war needs are really of sufficient volume to require that the tail end of the preference list be ignored to a great extent. The War Industries Board holds that there is not nearly enough steel production in prospect to meet all requirements, while many in the steel industry maintain that the war activities will not be able, during the next few months, to consume steel as rapidly as they are calling for it.

The discussion centers largely around a recent statement of the War Industries Board, that the requirements for the second half of the year total about 21,000,000 net tons, while the steel industry has never produced more than 16,500,000 net tons in a half year. But little explanation is given of these bare totals. There is no attempt made to indicate how the 21,000,000-ton total is made up, and as to the 16,500,000 tons production, assumed to be net tons, the fact is that in 1916 the production of finished rolled steel was about 34,200,000 net tons. The production in June was at the rate of about 36,000,000 net tons a year, assuming, as seems fair, that finished rolled steel was 75 per cent of the ingot tonnage, indicated by partial reports to have been at the rate of 43,500,000 gross tons a year.

While details have not been made public, it is evident that the 21,000,000 ton estimate must have been made up of material in two categories, first the stated requirements of the various Government activities—shipbuilding, shell manufacture, aircraft production, requirements of our allies, etc.; second, estimates of what the recognized commercial industries will require. From some of these industries estimates may have been received, but it is rather clear that "public utilities" were unable to make precise estimates, if indeed they individually made any at all.

It may be that the Shipping Board has overstated the amount of steel it will be able to use to January 1, 1919, and it may likewise be that it will be so successful in its work as to be able to consume more steel than it now estimates. What is clear is that with everyone trying to produce and consume a maximum it cannot be foretold precisely what will be done. The War Industries Board, therefore, sets a high mark for the steel industry to aim at, and is very conservative in allowing steel to pass to the less important commercial industries.

While according to the estimates are forecasts that there is not to be enough steel, the actual situation is not such by any means. There are many jobbers and manufacturing consumers who insist that they need more steel, but in most cases it is a case of looking into the future. There is, after all, very little if any work of real importance that is being retarded seriously if at all by lack of steel. The shipyards are in many cases accumulating steel and few if any are hampered by lack of steel. The forge shops, making shell blanks, are in the main well supplied and it is rumored that some have uncomfortably large stocks. At the shell factories there seems to be a fairly good supply

of material. The railroads doubtless could use more cars, but their performance is improving each month through better organization.

PIG IRON

If there were a normal supply of scrap, in proportion to pig iron, there would probably be no shortage of pig iron, for the requirements of the iron foundry trade in general are quite below normal. The total supply of scrap is insufficient, and the average character of scrap available is much below normal. Accordingly more pig iron is required, and with the increased proportion of pig iron for open-hearth furnaces using the pig and scrap process the ingot output is below the ordinary ratings of capacity. There is, however, no acute shortage of pig iron.

Chemical Market

COAL TAR PRODUCTS:—The last two weeks' period has been marked by the usual summer quietness although in those items which have shown some activity there have been slight increases in prices quoted. The saccharines have shown a continuing advance with the growing demand and the soluble still holds the preference.

Phenol:—Even inquiry has been very quiet for this material and large factors in its production are offering at 44c for material in large quantities on contract. Certain other directions continue to hold at 45c although on resale there is material available at less than either figure. Actual holdings of the English material are at local warehouses but holders state that it is not expected that further importations will be made. These are being offered at 45c, ex store.

Aniline Salts:—A very limited supply of this material is available even on the resale market and large manufacturers state that they are all sold up and are quoting 42c per pound. Demand is very good but holders are very hard to locate.

Saccharine:—The soluble material continues in favor and in very strong demand. Manufacturers are behind in filling contracts so far back as April and it has become almost impossible to locate holdings in second hands. The last sales reported were at \$32 on the soluble and \$31 on the insoluble.

Coumarin:—This product also is at present very short in supply as compared with demand and large interests who are succeeding at all in receiving shipments are doling them out sparingly among their regular customers. Such interests quote general prices of from \$28 to \$30, but as to the resale market in the few instances where actual holdings are known quotations are on the basis of \$32.50.

Benzoyl Soda:—The demand for this product has fallen off in the last week until there is practically no call. Purchases can be made at \$2.90 although the general holding is at \$3.00. The acid has assumed a level of from \$3.10 to \$3.25.

Dimethylaniline:—Demand is fair for this time but actual holdings are hard to locate. Small quantities are being offered from time to time and the present asking price for such lots is from 75 to 80c.

Paranitraniline:—The demand continues very good and new sources of supply are available. Such offerings are made at from \$1.75 to \$1.80.

Hexamethylenetetramine:—The demand for this material has fallen off somewhat from the active demand of a week or two ago and prices asked by large producers are now at \$1.05 and \$1.10 depending upon quantity. Large quantities cannot be delivered because of the scarcity of raw materials. Production is also affected by the present labor and transportation conditions and the fact that the government is taking over a large portion of the production.

Meta Amidophenol:—Supplies are not very large as the manufacture is for special color purposes and only small advance stocks of material are kept on hand. It is thought that the price of \$6.50 which is quoted in certain directions could be bettered on firm orders.

HEAVY CHEMICALS:—Although the market in general has been very quiet caustic soda has shown some little activity. In the case of saccharine a tendency to the returning of the old relations between the soluble and insoluble is evident.

Bichromate of Soda:—The majority of stocks are held by very strong houses and there is very little competition. The last sales noted were at 26½c and it was thought that 26½c could be done although there are some holders who will not shade 30c at the same time admitting that there seem no immediate prospects of receiving this price.

Caustic Soda:—Material from store is being quoted at \$3.80 and \$3.90 in several directions but from one source, an export house, it is reported that \$4.25 could not be shaded on a delivered price. Some 2700 tons were recently ordered through the Japanese government for one of the companies operating in Japan under subsidy. Part of this order was shipped in June and the balance was booked for July. The Japanese government arranged for the necessary permits.

Soda Ash:—Offers on double bags at Chicago have shown a slight increase as \$3 is last reported to have been paid as against \$2.65 recently. There is very little activity in the local market as bags are held at \$2 store in some quarters although some are quoting \$2.05 and \$2.10. The price on barrels New York continues at about \$2.90 with dense ash at \$3.85 or \$4 f.a.s.

Bichromate of Potash:—There has been a slight movement with offers generally made at 43 and 44c, without attracting much buying attention.

Lead Peroxide:—It is reported that new manufacturers are entering the field and will produce this material in powdered form on which they are quoting a price of 35c per pound and accepting orders for any quantities.

Calcium Carbide:—This item has been showing a gradual increase and is expected to reach ultimately the 20c level. The last general quotations for the sizes in greatest demand were at 19c at which the market appears to be very well established.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, JULY 8, 1918

Acetic anhydride.....	lb. 1.60 — 1.85
Acetone, drums.....	lb. Nominal
Acid, acetic, 28 per cent.....	lb. Nominal
Acetic, 56 per cent.....	lb. Nominal
Acetic, glacial, 99½ per cent, carboys.....	lb. Nominal
Boric, crystals.....	lb. 13½ — 15
Citric, crystals.....	lb. .82 — .88
Hydrochloric, C. P.....	lb. Nominal
Hydrochloric, 20 deg.....	lb. .02 — .02½
Hydrochloric, conc., 22 deg.....	lb. .02½ — .03
Hydrofluoric, 30 per cent in barrels.....	lb. .06 — .06½
Lactic, 44 per cent.....	lb. .15 — .16
Lactic, 22 per cent.....	lb. .06 — .07
Molybdate, C. P.....	lb. 6.90 — 7.40
Nitric, 36 deg.....	lb. .08½ — .10
Nitric, 42 deg.....	lb. .42 — .44
Oxalic, crystals.....	lb. .08 — .10
Phosphoric, 47-50 per cent paste.....	lb. .35 — .40
Phosphoric, ref. 50 per cent.....	lb. Nominal
Picric.....	lb. 3.25 — 3.50
Pyrogallic, resublimed.....	ton Nominal
Sulphuric, 60 deg.....	ton Nominal
Sulphuric, 66 deg.....	ton Nominal
Sulphuric, oleum (Fuming), tank cars.....	ton Nominal
Tannic, U. S. P., bulk.....	lb. 1.48 — 1.53
Tartaric, crystals.....	lb. .86 — .95
Tungstic, per lb. of W.....	lb. 1.70 — 1.75
Alcohol, sugar cane, 155 proof.....	gal. 4.91 —
Alcohol, wood, 95 per cent.....	gal. .91½ — .92
Alcohol, denatured, 180 proof.....	gal. .68 — .69
Alum, ammonium lump.....	lb. .04½ — .05½
Alum, chrome ammonium.....	lb. .18 — .19
Alum, chrome potassium.....	lb. .20 — .21
Alum, chrome sodium.....	lb. .12½ — .13
Alum, potash lump.....	lb. .09 — .09½
Aluminium sulphate, technical.....	lb. .02½ — .03
Aluminium sulphate, iron free.....	lb. .03 — .04
Ammonia aqua, 26 deg., carboys.....	lb. (Fixed Price) Nominal
Ammonia, anhydrous.....	lb. .15 — .16
Ammonium carbonate.....	lb. (Fixed Price) .15
Ammonium nitrate.....	lb. .07½ — .08
Ammonium, sulphate domestic.....	gal. 5.25 — 5.60
Amyl acetate.....	lb. .09½ — .17
Arsenic, white.....	lb. .65 — .70
Arsenic, red.....	ton 80.00 — 90.00
Barium carbonate, 99 per cent.....	ton 65.00 — 67.00
Barium carbonate, 97-98 per cent.....	ton 65.00 — 70.00
Barium chloride.....	lb. .04½ — .05
Barium sulphate (Blane Fixe, Dry).....	lb. .10 — .11
Barium nitrate.....	lb. .30 — .32
Barium peroxide, basis 70 per cent.....	lb. .02 — .03
Bleaching powder, 35 per cent chlorine.....	lb. .07½ — .10½
Borax, crystals, sacks.....	ton Nominal
Brimstone, crude.....	lb. .75 —
Bromine, technical.....	lb. Nominal
Calcium, acetate, crude.....	lb. .15 — .16
Calcium, carbide.....	ton 22.00 — 24.00
Calcium chloride, 70-75 per cent, fused, lump.....	lb. 1.60 — 1.70
Calcium peroxide.....	lb. .22 — .23
Calcium phosphate.....	lb. .09 — .09½
Calcium sulphate 98-99 per cent.....	lb. .08 — .09
Carbon bisulphide.....	lb. .15½ — .18
Carbon tetrachloride, drums.....	lb. 1.10 — 1.50
Carbonyl chloride (phosgene).....	lb. Nominal

Caustic potash, 88-92 per cent.....	lb. .77½ — .80
Caustic soda, 76 per cent.....	lb. 3.90 — 4.00
Chlorine, liquid.....	lb. (Fixed Price) .07½
Cobalt oxide.....	lb. 1.60 — 1.65
Coppers.....	lb. .02 — .02½
Copper carbonate.....	lb. .29 — .32
Copper cyanide.....	lb. .75 — .78
Copper sulphite, 99 per cent, large crystals.....	lb. .09½ — .09½
Cream of tartar, crystals.....	lb. .66 — .78
Epsom salt, bags, U.S.P.....	lb. 3.62 — 3.90
Formaldehyde, 40 per cent.....	lb. .16½ — .17½
Glauber's salt.....	lb. .02 — .03
Glycerine, bulk, C. P.....	lb. .62 — .65
Iodine, resublimed.....	lb. 4.25 — 4.30
Iron oxide.....	lb. .13 — .15
Lead acetate, white crystals.....	lb. .17 — .18
Lead arsenate (Paste).....	lb. .15 — .18
Lead nitrate.....	lb. Nominal
Litharge, American.....	lb. 1.1½ — .13
Lithium carbonate.....	lb. 1.50 — 2.00
Magnesium carbonate, technical.....	lb. .14 — .15
Nickel salt, single.....	lb. .14 — .15
Nickel salt, double.....	lb. .12 — .14
Phosgene, (see Carbonyl chloride).....	lb. 1.15 — 1.20
Phosphorus, red.....	lb. 1.35 — 1.40
Phosphorus, yellow.....	lb. .46 — .47
Potassium bichromate.....	lb. 1.35 — 1.36
Potassium bromide granular.....	lb. .38 — .40
Potassium carbonate calcined, 85-90 per cent.....	lb. .38 — .40
Potassium chlorate, crystals.....	lb. .60 — .70
Potassium iodide.....	lb. 3.75 — 3.80
Potassium muriate 80-85 p. c. basis of 80 p. c.....	ton 300.00 — 350.00
Potassium nitrate.....	lb. .27 — .31
Potassium permanganate U. S. P.....	lb. 1.75 — 3.75
Potassium prussiate, red.....	lb. 2.80 — 2.90
Potassium prussiate, yellow.....	lb. 1.10 — 1.20
Potassium sulphate, 90-95 p. c. basis 90 p. c.....	ton Nominal
Rochelle salts.....	lb. .44½ — .46
Salammoniac, gray gran.....	lb. .22 — .23
Salammoniac, white gran.....	lb. .17½ — .21
Sal soda.....	100 lb. 1.35 — 1.40
Salt cake.....	ton 35.00 — 40.00
Silver cyanide, based on market price of silver.....	os. .62½ — .64½
Silver nitrate.....	os. 2.00 — 2.12
Soda ash, 58 per cent, light, flat (bags).....	100 lb. 3.65 — 4.00
Soda ash, 58 per cent, dense, flat.....	100 lb. Nominal
Sodium acetate.....	lb. .02½ — .03
Sodium bicarbonate, domestic.....	lb. .26 — .27
Sodium bicarbonate, English.....	lb. .06 — .07
Sodium bisulphite, powd.....	lb. .25 — .25½
Sodium chlorate.....	lb. .37 — .42
Sodium fluoride, commercial.....	lb. .17 — .18
Sodium hyposulphite.....	lb. 2.40 — 2.50
Sodium molybdate, per lb. of Mo.....	lb. 2.50 —
Sodium nitrate, 95 per cent.....	100 lb. Nominal
Sodium nitrite.....	lb. .28 — .30
Sodium peroxide.....	lb. .35 — .45
Sodium phosphate.....	lb. .04 — .05
Sodium prussiate, yellow.....	lb. .53 — .55
Sodium silicate, liquid (60 deg.).....	lb. Nominal
Sodium sulphide, 30 per cent, crystals.....	lb. Nominal
Sodium sulphide, 60 per cent, fused.....	100 lb. Nominal
Sodium sulphite.....	lb. .25 — .35
Strontium nitrate.....	lb. .06 — .06½
Sulphur chloride, drums.....	lb. .15 — .40
Sulphur dioxide, liquid, in cylinders.....	100 lb. 4.05 — 4.60
Sulphur, flowers, sublimed.....	100 lb. 3.70 — 3.85
Sulphur, roll.....	ton Nominal
Sulphur, crude.....	lb. .28 — .29
Tin bichloride, 50 deg.....	lb. 1.00 — 1.10
Tin oxide.....	lb. .18 — .20
Zinc carbonate.....	lb. .15 — .15½
Zinc chloride.....	lb. Nominal
Zinc cyanide.....	lb. .14 — .16
Zinc dust, 350 mesh.....	lb. .13 — .14
Zinc oxide, American process XX.....	lb. .05 — .06
Zinc sulphate.....	lb. Nominal

Coal Tar Products (Crude)

Benzol, pure, water white.....	gal. .23 — .26
Benzol, 90 per cent.....	gal. .25 —
Toluol, in tank cars.....	gal. (Fixed Price) 1.50
Toluol, for non-military use, in drums.....	gal. (Fixed Price) 1.55
Xylo, pure, water white.....	gal. .45 — .55
Solvent naphtha, water white.....	gal. .18 — .28
Solvent naphtha, crude, heavy.....	gal. .12 — .15
Creosote oil, 25 per cent.....	gal. .40 — .55
Dip oil, 20 per cent.....	gal. .30 — .32
Pitch, various grades.....	ton 8.00 — 20.00
Carbolic acid, crude, 95-97 per cent.....	lb. 1.05 — 1.10
Carbolic acid, crude, 50 per cent.....	lb. .60 — .65
Carbolic acid, crude, 25 per cent.....	lb. .35 — .38
Cresol, U. S. P.....	lb. .18 — .20

Intermediates, Etc.

Alpha naphthol, crude.....	lb. 1.00 — 1.10
Alpha naphthol, distilled.....	lb. 1.60 — 1.70
Alpha naphthylamine.....	lb. .60 — .65
Aniline oil, drums extra.....	lb. .27 — .28
Aniline salts.....	lb. .37 — .42
Anthracene, 80 per cent.....	lb. Nominal
Benzaldehyde (f.f.e.).....	lb. 3.65 —
Benzidine, base.....	lb. 1.75 — 2.00
Benzoin, sulphate.....	lb. 1.40 — 1.50
Benzoic acid, U. S. P.....	lb. 3.10 — 3.25
Benzoyl acid of Soda, U. S. P.....	lb. 2.90 — 3.00
Benzyl chloride.....	lb. 2.60 — 2.70
Beta naphthol benzoate.....	lb. 10.00 — 12.00
Beta naphthol, sublimed.....	lb. .85 — .90
Beta naphthylamine, sublimed.....	lb. 2.65 —
Dichlor benzol.....	lb. .15 — .20
Diethylaniline.....	lb. 4.50 — 5.00
Dinitro benzol.....	lb. .36 — .38
Dinitrochlorbenzol.....	lb. .40 — .42

Dinitronaphthalene	lb.	.55	—	.60
Dinitrotoluol	lb.	.65	—	.75
Dinitrophenol	lb.	.55	—	.60
Dimethylaniline	lb.	.75	—	.80
Diphenylamine	lb.	1.00	—	1.10
H-acid	lb.	2.70	—	3.00
Metaphenylenediamine	lb.	1.75	—	2.00
Monochlorbenzol	lb.	.17	—	.20
Naphthalene, flake	lb.	.09	—	.09
Naphthalene, balls	lb.	.10	—	.10
Naphthonic acid, crude	lb.	1.20	—	1.30
Naphthylamin-di-sulphonic acid	lb.	1.00	—	1.20
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.55	—	.60
Ortho-amidophenol	lb.	.15	—	.18
Ortho-dichlor-benzol	lb.	1.00	—	1.25
Ortho-toluidine	lb.	.75	—	1.00
Ortho-nitro-toluol	lb.	4.00	—	4.50
Para-amidophenol, base	lb.	4.00	—	5.00
Para-amido-phenol, H. Ch.	lb.	.15	—	.20
Para-dichlor-benzol	lb.	1.75	—	1.90
Paranitraniline	lb.	1.50	—	1.60
Para-nitro-toluol	lb.	3.75	—	4.00
Paraphenylenediamine (base)	lb.	2.00	—	2.25
Para toluidine	lb.	3.50	—	4.00
Phthalic acid anhydride	lb.	.44	—	.46
Phenol, U. S. P.	lb.	5.00	—	7.00
Resorcin, technical	lb.	8.00	—	9.00
Resorcin, pure	lb.	.90	—	1.10
Silicic acid	lb.	1.50	—	2.00
Salol	lb.	.30	—	.32
Sulphanilic acid, crude	lb.	2.50	—	2.85
Tolidin	lb.	.85	—	.90
Toluidine-mixture	lb.	—	—	—

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	4.00	—	—
Corning, Ohio	bbl.	2.85	—	—
Somerset, Ky.	bbl.	2.60	—	—
Wooster, Ohio	bbl.	2.58	—	—
Indiana	bbl.	2.28	—	—
Illinois	bbl.	2.42	—	—
Oklahoma and Kansas	bbl.	2.25	—	—
Caddo, La., light	bbl.	2.25	—	—
Corsicana, Tex., light	bbl.	2.35	—	—
California	bbl.	1.24	—	1.57
Gulf Coast	bbl.	1.35	—	—

Fuel Oil

New York	gal.	.11	—	—
Pittsburgh	gal.	.07	—	1.10
Oklahoma-Kans.	bbl.	1.05	—	2.75
Texas	bbl.	1.85	—	2.35
Los Angeles	bbl.	1.60	—	—
San Francisco	bbl.	1.60	—	—

Gasoline (Wholesale)

New York	gal.	.24	—	—
Boston	gal.	.25	—	—
Pittsburgh	gal.	.28	—	—
Chicago	gal.	.22	—	—
Oklahoma	gal.	.25	—	—
San Francisco	gal.	.20	—	—

Lubricants

Black, reduced, 29 gravity, 25-30 cold test.	gal.	.23	—	.24
Cylinder, light	gal.	.40	—	.42
Cylinder, dark	gal.	.39	—	.41
Paraffine, high viscosity	gal.	.40	—	.41
Paraffine, .903 sp. gr.	gal.	.36	—	.38
Paraffine, .885 sp. gr.	gal.	.25	—	.27

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f. o. b. Florida	gal.	.44	—	—
Pine oil, steam-distilled, ap. gr. 0.923-0.940	gal.	.58	—	.60
Pine oil, destructively distilled	gal.	.58	—	.60
Pine-tar oil, sp. gr. 1.02-1.035	gal.	.35	—	—
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.42	—	—
Pine-tar oil, ref., light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	—
Pine-tar oil, ref., heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.28	—	—
Pine-tar oil, ref., thin, sp. gr. 1.060-1.080	gal.	.32	—	—
Turpentine, crude, ap. gr. 0.870-0.900	gal.	.45	—	—
Hardwood oil, f. o. b. Michigan, sp. gr. 0.960-0.990	gal.	.23	—	—
Hardwood oil, f. o. b. Michigan, sp. gr. 1.06-1.08	gal.	.23	—	—
Wood creosote, ref. f. o. b. Florida	gal.	.31	—	—

Vegetable and Other Oils

China wood oil	lb.	.26	—	.30
Cottonseed oil, crude	lb.	.20	—	.22
Linseed oil, raw, cars	gal.	1.76	—	1.82
Peanut oil, crude	gal.	1.36	—	1.37
Rosin, oil, fast run	gal.	.60	—	—
Rosin oil, fourth run	gal.	.73	—	—
Soya bean oil, Manchuria	lb.	.16	—	—
Turpentine, spirits	lb.	.63	—	.64

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	—	42.00
Barytes, floated, white, domestic	ton	32.00	—	36.00
Beechwax, white, pure	lb.	.42	—	.43
Casein	lb.	.14	—	.28
Chalk, light, precipitated, English	lb.	—	Nominal	—
China clay, imported, lump	ton	20.00	—	40.00
China clay, domestic, lump	ton	15.00	—	22.50
Feldspar	ton	8.00	—	12.00
Fluorspar, gravel, f. o. b. mines	ton	30.00	—	—
Fuller's earth, powdered	100 lb.	1.50	—	2.00
Graphite, flake	lb.	.10	—	.25
Osokerite, crude	lb.	.75	—	.80
Osokerite, American, refined, white	lb.	.85	—	.90
Red lead, dry, carloads	lb.	.10	—	.11

Rosin, 280 lb.	bbl.	11.00	—	12.60
Soapstone	ton	15.00	—	25.00
Talc, American, white	ton	20.00	—	40.00
White lead, dry	lb.	.09	—	.10

Refractories, Etc.

(F. O. B. Works)

Chrome brick	net ton	175.00	—	—
Chrome cement	net ton	75.00	—	—
Clay brick, 1st quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined, powdered	ton	50.00	—	65.00
Magnesite, dead burned	net ton	50.00	—	60.00
Magnesia brick, 9x4x2	net ton	110.00	—	125.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocobaltitanium, 15-18 per cent, carloads, f. o. b. Niagara Falls, N. Y.	ton	200.00	—	250.00
Ferrocerium	lb.	15.00	—	20.00
Ferrochromium, per lb. of Cr.	lb.	—	—	—
Fermanganese, domestic, 70 per cent basis	ton	250.00	—	—
Fermanganese, English	ton	325.00	—	—
Ferromolybdenum, per lb. of Mo	lb.	5.00	—	—
Ferrosilicon, 75 per cent, f. o. b. N. Y.	ton	180.00	—	190.00
Ferrosilicon, 50 per cent, carloads, del. Pittsburgh	ton	160.00	—	170.00
Ferrotungsten, 75-85 per cent, f. o. b. Pittsburgh	lb.	2.35	—	2.40
Ferrouranium, f. o. b. works, per lb. of U.	lb.	7.50	—	—
Ferrovanadium, f. o. b. works	lb.	—	—	—

Ores and Semi-finished Products

Antimony ore, 45 per cent minimum, f.o.b. Cal. per unit	ton	1.50	—	1.55
Chrome ore, 43 per cent and over, New York, per unit	ton	1.20	—	—
Manganese ore, 48 per cent and over, per unit	ton	80.00	—	100.00
Manganese ore, chemical	lb.	1.25	—	—
Molybdenite, per lb. of Mo ₂	ton	24.00	—	—
Tungsten, Wolframite, per unit of WO ₃	ton	24.00	—	36.00
Uranium oxide, 96%	lb.	3.25	—	—
Vanadium pentoxide, 99%	lb.	10.50	—	17
Pyrites, foreign	unit	.17	—	—
Pyrites, domestic	unit	.28	—	30

Plant Supplies

BUILDING MATERIALS

Common clay bricks	M	12.00	—	—
Hollow tile, 4 x 12 x 12	M	56.00	—	—
Hollow tile, 12 x 12 x 12	M	162.00	—	—
Lime	ton	16.50	—	—
Portland cement	bbl.	2.59	—	—
Single glass (82-lb.), 10 x 26-16 x 24	ton	21.00	—	27.00
Double glass (164 lb.), 10 x 26-16 x 29	ton	31.00	—	39.00
Yellow pine lumber	M	39.00	—	45.00
Fir lumber	M	38.00	—	53.00
Hemlock	M	24.50	—	—
Tarred felt (14-lb.-sq.)	ton	64.00	—	—
Roofing pitch	ton	14.00	—	22.00
Asphalt coated roofing (35-55-lb. sq.)	sq.	1.30	—	2.50
State surfaced asphalt shingles	sq.	5.25	—	5.50
Corrugated galvanized iron	ton	109.00	—	127.00
Red oxide (Ppte. Copperas)	lb.	15.00	—	20.00
Native red oxide	lb.	3.25	—	8.00
Red metallic paint	lb.	1.20	—	1.50
White lead in oil	lb.	13.50	—	11.42
Red lead in oil	lb.	14.00	—	11.84

INDUSTRIAL NEWS

Plant Construction—Catalogs—New Publications

Construction and Operation

Arkansas

HARRISON.—The Harrison Mining & Milling Co., located in Crooked Creek Valley Mining District, will rebuild its 75-ton mill recently destroyed by fire. The company is in the market for sludge and slime tables, belts, mill hardware, mill lumber, and air compressors. Estimated cost, \$18,000. George Constant, Harrison, superintendent.

MENA.—The Abbott, Rebholts and Stewarty Mining Co., Baxter Springs, Kan., will build a concentration plant here. Estimated cost, \$25,000. The company is in the market for steam shovel, crushers, washers, belts, cars, engine and boiler. J. Abbott, superintendent.

MOUNTAIN HOME.—The Mattie May Mining Co. will build a 150-ton concentration plant and is in the market for sludge and slime tables, engines, boilers, crushers, air compressors, lumber, mill hardware, roofing, piping, belts and cables. Estimated cost, \$40,000. E. Zimmerman, superintendent.

BATESVILLE.—The Vance Mining Co. will build a 100-ton concentration plant and is in the market for steam shovel, cars, track, log washer, lumber, mill hardware, engine and boiler. Estimated cost, \$25,000. C. H. Plumb, Miners Bank Bldg., Joplin, Mo., superintendent.

Alabama

ASHLAND.—The Griesemer Graphite Co. will rebuild its concentration plant recently destroyed by fire. Estimated cost, \$75,000. F. C. Hooper, Ashland, superintendent.

Arizona

AJO.—The New Cornelia Copper Co. will build a flotation plant for the care of new ore production, and will later build a smelter.

WALKER.—The Black Diamond Mining & Developing Co., Prescott, will build a concentration and flotation mill and install machinery for same. Estimated cost between \$10,000 and \$15,000. J. Irwin, P. O. Box 403, Prescott, superintendent.

Connecticut

NEW HAVEN.—Yale University will build a 5-story, 100 x 100 ft., reinforced concrete, brick and steel laboratory. Estimated cost, \$300,000. Day & Klauder, 925 Chestnut St., Philadelphia, Pa., architects.

PUTNAM.—The Manhasset Manufacturing Co., 83 Canal St., has awarded the contract for the construction of a 2-story, 40 x 100 ft., concrete and brick factory, for the manufacture of tires, to Torrington Building Co., 197 Water St., Torrington. Estimated cost, \$40,000.

Illinois

CHICAGO.—The Symington-Chicago Corporation, 122 South Michigan Ave., has awarded the contract for the construction of a 1- and 2-story brick and steel munition plant on Seventy-fourth and Ashland Sts., to Thompson-Starrett Co., 175 West Jackson St. Cost between \$5,000,000 and \$6,000,000.

HEGEWICH.—The General Chemical Co., 25 Broad St., New York City, has awarded the contract for the construction of a 120 x 140 ft., factory building, to the Austin Co., 16112 Euclid Ave., Cleveland, O.

Kansas

BAXTER SPRINGS.—The Chilto Lead & Zinc Co. will build a 250-ton concentration plant. Estimated cost, \$45,000. The company is in the market for oil engine, lumber, mill hardware, sludge tables, air compressors, belts and crushers. Frank Chilto, Baxter Springs, superintendent.

BAXTER SPRINGS.—The Cook & McCullough Mining Co. will build a 150-ton concentration plant, and is in the market for sludge and slime tables, crushers, air

compressors, conveyors, air pipes, belts, jigs, drills, ore cars, track, engines, boilers, lumber, mill hardware and concrete for mill bases. Estimated cost, \$40,000. W. McCullough, Baxter Springs, superintendent.

BAXTER SPRINGS.—The Euterpe Mining Co. will remodel its 200-ton concentration plant and is in the market for roofing, lumber, belts, conveyors, hardware, sludge tables, drills and crushers. Estimated cost, \$25,000. C. Clark, superintendent.

CRESSWELL.—Frank Nicholson and Frank Harrington, 202 Sargent St., Joplin, Mo., will build a 150-ton concentration plant at their mine here, and are in the market for mill machinery, lumber, hardware, oil engine, sludge and slime tables, crushers, ore cars, ore bins and air compressors. Estimated cost, \$33,000. O. W. Sparks, superintendent.

TREECE.—The Miami-Texas Mining Co. will remodel its 250-ton concentration plant here. Estimated cost, \$25,000. The company is in the market for lumber, belts, sludge and slime tables, rollers for crushers, air compressors, conveyors, ore cars, and track. F. W. Stallings, Treece, superintendent.

Louisiana

NEW ORLEANS.—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will build four ammunition plants here. Estimated cost, \$4,500.

Maryland

BALTIMORE.—The city will enlarge the filtration plant at Lake Montebello, build an additional filtered water reservoir and also a plant for the manufacture and storage of alum. W. E. Lee, City Hall, water engr.

CUMBERLAND.—The American Cellulose Co., 52 Vanderbilt Ave., New York City, has awarded the contract for the construction of a 1-story plant for the manufacture of cellulose for war purposes to G. A. Fuller, Fuller Building, New York City. Estimated cost, \$10,000,000.

CURTIS BAY (Baltimore P. O.)—The Curtis Bay Copper & Iron Works will build three 1-story, 60 x 120 ft. steel and hollow tile additions to its plant here, machine shop type. W. F. Cochrane, South Baltimore, engineer.

INDIAN HEAD.—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will build a nitrate plant here. Estimated cost, \$9,000,000.

INDIAN HEAD.—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the remodeling of chemical laboratory at the Naval Station here, to Austin Co., 1026 Bulletin Building, Philadelphia, Pa. Estimated cost about, \$25,000. Noted June 30.

INDIAN HEAD.—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of a chemical laboratory here, to Austin Co., 1313 H St., N. W., Washington, D. C. Estimated cost, \$25,350.

Michigan

GRAND RAPIDS.—The Voleine Brass Works, Monroe Ave., will build a 5-story addition to its plant. Osgood & Osgood, architects.

Missouri

GRANBY.—The Carolyn Metal Co., Oklahoma City, Okla., will remodel and increase the capacity of its 150-ton mill to 250 tons, and is in the market for sludge and slime tables, roofing lumber, crushers, belts, and air compressors. Estimated cost, \$25,000. N. Darling, superintendent.

GRANBY.—E. L. Plank, Everitt Smith and E. Raybury, will build a 150-ton concentration plant at their mine here and are in the market for sludge and slime tables, roofing, engine, ore cars, crushers, lumber, mill hardware, air compressors and conveyors. Estimated cost, \$65,000. E. L. Plank, superintendent.

JOPLIN.—The Badger Mining Co. will build a 250-ton concentration plant and is in the market for sludge and slime tables, engine, boilers, belts, crushers, lumber,

mill hardware, ore tubs, ore cars, track, rope, and roofing. Estimated cost, \$60,000. A. Foster, 401 Miners Bank Building, manager.

JOPLIN.—The Rashgo Mining Co., will build a 150-ton concentration plant near the Sunnyside Mining Field and is in the market for sludge and slime tables, crushers, air compressors, lumber, mill hardware, conveyors, belts, track and cars. Estimated cost, \$45,000. W. M. Randell, Joplin, superintendent.

ORONOGO.—A. F. Holt will rebuild the 200-ton concentration plant at his mine, recently destroyed by fire, and is in the market for sludge and slime tables, oil engine, belts, air compressors, track, lumber, mill hardware, drills and ore crushers. Estimated cost, \$25,000.

SENECA.—The Mt. Nebo Lead & Zinc Co. will build a 200-ton concentration plant, and is in the market for mill lumber, mill hardware, belts, cables, ore cans, sludge and slime tables, ore crushers, conveyors, air compressors, boilers and engine. Estimated cost, \$40,000.

ST. LOUIS.—The Monsanto Chemical Works, 1800 South Second St., will build an addition to its plant. Brenneke & Fay, Fullerton Building, engineers.

ST. LOUIS.—The Moon Motor Car Co., 4401 North Main St., has awarded the contract for the construction of a 4-story, 60 x 66 and 40 x 126 ft., reinforced concrete, munition factory, to Greve Construction Co., Century Building. Estimated cost, \$48,000. Noted June 15.

ST. LOUIS.—The Scullin Steel Co., 6700 Manchester St., has awarded the contract for the construction of a 2-story, 44 x 283 ft., reinforced concrete, brick and steel munition plant at 2514 Ecco St., to Crowell, Lundorff, Little Co., 1951 East Fifty-seventh St., Cleveland, Ohio. Estimated cost, \$200,000.

WACO.—The Blue Rock Mining Co. will build a 250-ton concentration plant and is in the market for slime and sludge tables, crushers, conveyors, air compressors, lumber, mill hardware, roofing, engine and boilers. Estimated cost, \$60,000.

WACO.—The Miami-Waco Lead & Zinc Co. will build a 250-ton concentration plant requiring ore crushers, engine, compressors, drills, mill hardware, jigs, sludge tables, slime tables, belts, lumber, ore cars and track. Estimated cost, \$40,000. W. P. Cunningham, Waco, superintendent.

WACO.—The Central Zinc Co. will remodel the 400-ton mill which it recently purchased and install mill hardware, lumber, sludge tables, air compressors, belts, ore crushers, boilers, ore cars and track. Estimated cost, \$20,000. Frank Danglade, Waco, superintendent.

WACO.—The Crescent Lead & Zinc Co. will build a 250-ton concentration plant. Estimated cost, \$35,000. The company is in the market for a gas engine, crushers, air compressors, rollers, tables, jigs and mill hardware. Glen Smith, Waco, superintendent.

New Jersey

BLOOMFIELD.—The International Arms & Fuse Co., Bloomfield Ave., will build a 3-story, 75 x 100 ft. addition to its plant.

HARRISON.—The Crucible Steel Co., South Fourth St., has awarded the contract for the construction of a 1-story, 200 x 400 ft. rolling mill, to W. H. & F. W. Cane, Woolworth Building, New York City. Estimated cost, \$500,000.

JERSEY CITY.—The Metal & Thermit Corporation, 527 Johnston Ave., will build a 1-story, 35 x 100 ft., steel plant. Estimated cost, \$15,000.

KEARNEY (Arlington P. O.)—Henry Ford, Detroit, Mich., will build a 1-story, 400 x 1400 ft., brick and steel factory on the Passaic River here for the construction of patrol boats and submarine chasers. Estimated cost, \$2,000,000.

NEWARK.—The Butterworth-Judson Co., Ave. R, will build a 1-story, 40 x 94½ x 190 ft., brick and steel chemical plant. Estimated cost, \$118,000.

NEWARK.—The E. I. duPont de Nemours Co., duPont Building, has awarded the contract for the construction of a 1-story, 28 x 49 ft. and 2-story, 38 x 103 ft., brick factory buildings, to G. Tomlinson & Son, 2619 South 13th St., Philadelphia, Pa. Estimated cost, \$27,160.

New York

BUFFALO.—The Atlas Steel Castings Co., 1963 Elmwood Ave., has awarded the contract for the construction of a 1-story, 60 x 200 ft. plant, to the Austin Co., 18112 Euclid Ave., Cleveland, O.

BUFFALO.—The Linde Air Products Co., 155 Chandler St., has awarded the contract for the construction of a 1-story plant on Fillmore Ave., to J. W. Cowper Co., Fidelity Building. Estimated cost, \$10,000.

CHATEAUGAY.—The High Falls Pulp & Paper Co. will build a 1-story, reinforced concrete and brick pulp and paper mill. Estimated cost, \$75,000. Thompson & Bender, Gurney Building, Syracuse, engineers.

HASTINGS.—The Cantonment Division, War Department, Washington, D. C., will build a large chemical plant here for the use of the Ordnance Department. First unit to cost, \$500,000.

Ohio

CLEVELAND.—The Great Western Oil Co., 2846 East Thirty-seventh St., will build an oil refining plant to replace the one recently destroyed by fire. W. W. Hodges, Schofield Building, architect.

CLEVELAND.—The Lakeside Hospital, Lakeside Ave. and East Twelfth St., has awarded the contract for the construction of a 2-story, 42 x 62 ft., brick and concrete addition to its laboratory, to Crowell, Lundoff, Little Co., 1951 East Fifty-seventh St. Estimated cost, \$20,000.

Oklahoma

CENTURY.—The Crescent Mining Co. will build a 200-ton concentration plant. Estimated cost, \$45,000. The company is in the market for sludge tables, crushers, rollers, conveyors, air compressors, jigs, belts, mill hardware, mill lumber, roofing, engine and cables. H. L. Woods, Commerce, superintendent.

COMMERCE.—The Big Jim Mining Co. will build a 200-ton concentration plant. The company is in the market for mill lumber, roofing, sludge and slime tables, mill hardware, engine, crushers, air compressors, jigs, and conveyors. Estimated cost, \$60,000. G. W. Nesmith, Commerce, superintendent.

COMMERCIAL.—The Miami Volunteer Mining Co., Miami, will remodel and enlarge its 200-ton concentration plant, and is in the market for sludge and slime tables, oil engine, belts, mill hardware, lumber and crushers. Estimated cost, \$25,000. J. L. Hawthorne, Tulsa, Okla., superintendent.

DOUTHAT.—J. J. McLellan and Ray Munson will build a 500-ton concentration plant at their mine and are in the market for sludge and slime tables, jigs, cleaner, crushers, lumber, hardware, engine and boilers. Estimated cost, \$65,000. Ray Munson, Douthat, superintendent.

HOCKERVILLE.—McCurdy Bros. Mining Co., Quapaw, will build a 200-ton concentration plant and is in the market for sludge and slime tables, lumber, hardware, engine, air compressors, conveyors and crushers. Estimated cost, \$65,000.

HOCKERVILLE.—The Tulsa-Sapulpa-Miami Associated Mines Co. will build a 200-ton concentration plant and is in the market for sludge and slime tables, crushers, pipes, lumber, hardware, air compressors, conveyors, roofing and engine. Estimated cost, \$65,000.

LAWTON.—The Development Co. will remodel its concentration plant, increasing the capacity from 250 tons to 500 tons and is in the market for sludge and slime tables, air compressors, pipes, engine, cables, crushers, mill hardware, mill lumber, and ore cars. Estimated cost, \$40,000. E. E. Jayne, Lawton, superintendent.

LINCOLNVILLE.—The White Swan Co., West Plains, Mo., will build a 200-ton concentration plant at its mine here. Estimated cost, \$65,000. The company is in the market for sludge and slime tables, mill lumber and hardware, air compressors, ore cars, ore cans, track, crushers, engine, and boilers. J. H. Stoddard, West Plains, Mo., superintendent.

OKMULGEE.—The city will build a filtration plant, sewage disposal plant and new mains. Estimated cost, \$150,000. Burns & McDonnell, 402 Interstate Building, Kansas City, Mo., engineers.

QUAPAW.—The Allied Lead & Zinc Co. will remodel its 250-ton concentration plant and is in the market for sludge tables, roofing, lumber, hardware, belts and compressors. Estimated cost, \$45,000.

QUAPAW.—The Lead Cave Mining Co. will remodel its 200-ton concentration plant and install sludge and slime tables, new belts, cables, ore cars, rope, roofing lumber and hardware. Estimated cost, \$60,000.

QUAPAW.—The Six Mining Co., Miami, will build a 600-ton concentration plant and

is in the market for sludge and slime tables, roofing, mill hardware, lumber, crushers and engine. Estimated cost, \$65,000.

QUAPAW.—The Spelter Mining Co. will build a 200-ton concentration plant east of Quapaw. The company is in the market for sludge and slime tables, crushers, lumber, roofing and hardware. Estimated cost, \$65,000.

TAR RIVER.—The Maxine Co. will build a 400-ton concentration plant. Estimated cost, \$85,000. The company is in the market for a gas driven engine, crushers, air compressors, belts, lumber, roofing, conveyors, mill hardware, sludge and slime tables, etc. W. C. Miller, Tar River, superintendent.

Pennsylvania

CHESTER.—The Crown Smelting Co. will build a 1-story, 17 x 100 ft., addition to its pattern works.

ERIE.—City plans to build intercepting sewers and sewage treatment works. Estimated cost, \$800,000. Chester & Fleming, Union Bank Building, Pittsburgh, engineers.

LANCASTER.—The Bottonfield Tire Co., Woolworth Building, will build an addition to its plant. Estimated cost, \$10,000. M. R. Evans, 10½ East Orange St., architect.

MARCUS HOOK.—The National Aniline & Chemical Co., Inc., has awarded the contract for the construction of oxide pits, to the Austin Co., 16112 Euclid Ave., Cleveland, Ohio.

NICETOWN.—The Midvale Steel Co., Widener Building, Philadelphia, will build a 1-story, 113 ft. 8½ in. x 482 ft. rough machine shop, a 1-story, 74 ft. 11½ in. x 450 ft. heat treatment plant, and a 1-story, 183 x 562 ft. finish machine shop, all buildings to be of steel construction.

Rhode Island

BRADFORD.—The Bradford Dyeing Association will build a 1-story, 69 x 200 ft. brick and timber mill building. Estimated cost, \$30,000. Jenks & Ballon, Grosvenor Building, Providence, engineers.

Tennessee

KINGSPORT.—The Cantonment Division, War Department, Washington, D. C., will build a large chemical plant here for the use of the Ordnance Department. First unit to cost, \$500,000.

Texas

CULBERSON CO.—Edward Hart, Bartow, and others, will build a plant for refining raw sulphur and for the manufacture of sulphuric acid.

FT. WORTH.—The city will build a sewage disposal plant. A. Lord, waterworks commissioner.

WACO.—The city plans to build a sewage disposal plant. Rollen J. Windrow, city engineer.

Virginia

HAMPTON.—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will build an addition to the laboratory here. Estimated cost, \$13,000.

KERMIT.—The Carroll Development Co., 312 McBain Building, Roanoke, Va., will build a plant here for developing silica deposits. E. A. Schubert, president.

Washington

SEATTLE.—The Northwest Motor Co., 618 East Pike St. will build a 90 x 250 ft. steel foundry for the production of iron and steel on industrial sites 6 and 7, King Co. Estimated cost, \$150,000.

Industrial Notes

THE QUIGLEY FURNACE SPECIALTY COMPANY, INC. has opened a branch office in Pittsburgh at 427 Oliver Building, to handle the sale of powdered coal equipment, and Hytempite furnace cement. The powdered coal engineering department will be in charge of Mr. L. V. Marso, formerly maintenance engineer of the A. M. Byers Company plant at Girard, Ohio, and the specialties department will be taken care of by Mr. J. L. Cummings, Jr., formerly connected with the sales department of the company at New York.

THE ELECTRIC FURNACE CONSTRUCTION CO., Philadelphia, recently placed in operation a ½-ton electric furnace of the Greaves-Etchells type at the plant of the Ford Motor Co., Detroit. It is operating on nickel-chrome steel for special airplane

work, producing heats in as low as 1½ hours. There are a number of these furnaces in operation in England but this is the first one of the type to be placed in operation in the United States. The following furnaces will be placed in operation: Two 3-ton furnaces at the plant of the Halcomb Steel Co., Syracuse, N. Y.; one 6-ton furnace at the Navy Yard, Puget Sound, Wash., and two 6-ton furnaces at the plant of the American Radiator Co., Buffalo, N. Y.

THE ELECTRIC FURNACE INDUSTRIES WAR SERVICE COMMITTEE has been organized by manufacturers of electric furnaces for the duration of the war or for such time as it is apparent that there may be a need for the same. Its object is to compile and furnish information to the Government relative to electric furnace industries in the production of steel, ferrous and non-ferrous alloys, and metals where the melting problem is concerned. The following manufacturers have become members of the new organization: Hamilton & Hansell Co., New York; John A. Crowley Company, New York; Ajax Metal Company, Philadelphia; American Metallurgical Corp., Philadelphia; Electric Furnace Construction Co., Philadelphia; Pittsburgh Furnace Company, Pittsburgh; Booth-Hall Furnace Company, Chicago, Ill.; Industrial Electric Furnace Co., Chicago, Ill.; C. W. Leavitt & Co., New York City; Ludlam Electric Furnace Co., Woolworth Bldg., N. Y.; T. W. Price Engineering Company, New York; Beckman & Linden Corp., San Francisco, Cal.

THE WELLMAN-SEAVIER-MORGAN CO., Cleveland, O., has recently ordered from the H. Koppers Co. five coke pushers for the Jones & Laughlin Steel Co., and two for installation in Fairmount, W. Va. A coke pusher is also ordered for the Wilputte Coke Oven Corporation, New York.

THE ISLAND PETROLEUM CO., and the Concrete Products Co., whose plants are on Neville Island, Pittsburgh, Pa., have been notified by the Government that their properties are wanted for the United States Steel Corporation's new gun and projectile plant. They have been advised that while immediate ownership is desired by the Government, actual possession is not wanted at once and they will be given enough time to remove their plants to other locations. The Witherow Steel Co., another plant on Neville Island, has been notified by the Government not to make additions as planned. The entire island will be wanted by the Government and all manufacturing plants on it will have to seek other locations.

THE CLEVELAND FURNACE CO., Cleveland, Ohio, is relining its No. 2 furnace and making some other improvements to its plant which will include the building of a ladle-cleaning house, the installation of a new pig-casting machine and enlarging the furnace hearth from 15 to 17 ft. which will increase the daily capacity of the stack from 400 to 500 tons.

THE SAMSON-SIEVE GRIP TRACTOR CO., Sacramento, Cal., is installing a 5-ton Heroult electric furnace to make steel castings.

THE ENTERPRISE FOUNDRY, South San Francisco, Cal., has recently installed an electric furnace of its own design.

THE T. W. PRICE ENGINEERING CO., INC., has just sold a 5-ton vom Baur electric furnace with basic bottom to the Hercules Steel Casting Co., Inc., Milwaukee, Wis., which is expected to be in operation by October.

THE MESTA MACHINE CO., Pittsburgh, Pa., has placed a contract with the Smith Gas Engineering Co., Dayton, Ohio, for gas producers, which will be equipped to furnish 40,000,000 cu. ft. of producer gas every 24 hr. of 140 B.t.u. per cu. ft. of calorific value, for its plant at Mesta, Pa., near Pittsburgh, to replace both fuel oil and natural gas. The equipment will be installed in eight units, each capable of gasifying about 3500 lb. of bituminous coal per hr. The first four units installed are expected to be completed during the coming winter, the other four will be built later.

STANDARDIZATION OF CATALOGS.—The National Association of Purchasing Agents has adopted a page measuring 7½ by 10½ inches as the standard size for catalogs which will be furnished to purchasing agents. The same size for catalogs has been adopted by the National Retail Hardware Association and the National Association of Brass Manufacturers. The cooperation of manufacturers is urged in bringing about the standardization of catalogs.

THE DORR COMPANY will move its New York office from 17 Battery Place to the Architects Building, 101 Park Avenue, corner of 40th Street.